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THE FEASIBILITY OF COAL MINE COOPERATIVES: A PRELIMINARY REPORT AND ANALYSIS

by

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I. PROJECT PARAMETERS

The objective of this analysis is a preliminary report on the feasibility of marketing/transportation cooperatives composed of small producing coal mines. The research is confined to existing documents. Existing, rather than potential, mines are discussed.

For the purposes of this study, a small coal mine is defined as one producing between 100,000 and 500,000 tons of coal per year. In 1970, there were approximately 671 of these mines; average production was about 209,000 tons per year. There were 617 mines in the 50,000-100,000 class and 2,104 in the 10,000-50,000 class. The former averaged 70,000 and the latter 24,000 tons per year. Secondly, in this study, unit train loadings are assumed to be 1-1.5 million tons per year.

According to the National Coal Association, in 1970, bituminous coal was produced from 5,601 mines. Of these, 4,006, or 71.5 percent, produced only 9.9 percent of total bituminous coal production. The top size of these small mines was only 50,000 net tons. If we assume that annual mining operations were undertaken over 220 days, then the largest of the small mines produced only 227 tons of coal per day; just over two carloads per day. It is possible that reduction in the number of these small mines owe more to safety and health regulations than to transportation, equipment or marketing problems.

The major problem for the small mines is that they are too small for efficient use of rail transport systems. Consider only unit trains. The loading system list includes stock piles, storage silos, reclaiming equipment, scales, conveyors, surge bins, loading chutes, loading tunnels, loading structures, electricity and labor. The actual installation depends on whether the operation is for 10 MMT/Y for 20 years or 3 MMT/Y for 5 years. The small operation implies 60 mines of the 50,000 T/Y class.

A typical unit train loading set-up loads 3 trains per day, each of 100 cars and each car of 100 tons net lading. In addition, one and one-half train loads of storage is provided at the start of each train loading. The loading rate is 4,000 T/hour. This loading rate is the equivalent of about three-fifths of the annual output of one 50,000 T/Y mine in a single day.

The biggest unit train usually placed for loading at a mine is about 10,000 tons; the smallest, about 3,000-3,500 tons. With single track loading this amount to a range of 38 to over 100 cars. Assuming that the 50,000 T/Y mines produce 237 T/D, the smallest trains requires the output of over 13 mines. For and efficient operation more than one train is required. As a purely economic exercise, it is not certain that there is a positive payout to the energy economy by maintaining the number of the smallest mines. With respect to the proposed ICC ruling concerning unit trains, it might be profitable to: (1) attempt

to show that the unit train and the rates implied are in the national interest, (2) show that for the large shipper, to equalize rates actually means that he is discriminated against with respect to price and (3) show that a rate revision would lead to an acceleration by the consumers (i.e., private trains).

Finally, very small mines have small reserves. This does not help long term planning. Additionally, with reference to a cooperative, if a mine is closed because the reserves are used up, then another member must be found for the cooperative if the cooperative is to continue. Estimates of reserves for particular mines are proprietary and we cannot obtain such information, at least over a very short period of time.

The following areas are reviewed:

1. Legal Aspects - Federal law and the laws of some major coal states are reviewed to determine the statutes bearing on this type of producer cooperative. Of particular relevance are factors pertaining to support, prohibition and financing.

2. Potential Cooperative Identification - For the mine class size of 100,000-500,000 tons per year, existing literature and state surveys are examined to determine mine location and proximity to similar sized mines. A 25-30 mile radius from the shipping point defines proximity. The result is an approach to the number, identification and location of potential cooper-tives.

3. Coal Preparation - A number of coal preparation configurations, principally crushing and washing, are examined with respect to their throughput and optimal use. This can be related to the number of mines in a coop and the output of those mines. It is assumed that the facilities are cooperatively owned and operated.

4. Coal Quality Control - Based on available literature, an attempt is made, in those areas deemed favorable to coops, to investigate the similarity of coals from a number of mines vis-a-vis the similarity of coals from a single large mine or mines such that the product received by the consumer is comparatively uniform.

5. Transportation - Unit Trains - An examination is made of the facilities needed consistent with annual shipment of 1-1.5 million tons of coal per year. This is related to the number of mines in the coop and their output. Unit train tariffs vary widely, but some identification of the relation between length of train, number of trips or regularity, number of loading points and number of destinations is provided.

6. Transportation - Mine to Railhead or Preparation Facility - The modes of transport investigated include truck, conveyor belt and high pressure pneumatic pipeline. Throughput and costs, on a comparative basis, are discussed.

7. Facilities - Repair, maintenance, warehousing and joint purchasing of mining equipment are discussed in the context of the wide diversity of equipment currently in use and the advantages of standardization.

8. Exclusions - Operations of the proposed cooperatives such as accounting, disbursements, marketing services and joint exploration are excluded. Similarly, central training facilities are excluded. There is a current movement in the universities of the major coal states to provide such training. Southern Illinois University (Carbondale) is a recent example.

It is understood that this research is not proprietary. The results may be disseminated outside the Federal Energy Agency with full financial credit given to the Agency.

II. SUMMARY AND REVIEW

There can be little doubt that a cooperative made up of several mines is both technically and economically feasible. It is also clear that the formation of the cooperative confers advantages on the membership. This study presents a number of facets which should be considered before any action is undertaken with respect to the setting up of cooperatives.

Section III, Legal Aspects of Coal Cooperatives, indicates that while there is no legal prohibition against their formation, unlike a number of the other areas where cooperatives exist, there is no special enabling legislation. Furthermore, it is found that the cooperative is not exempt from the anti-trust laws and as this may be construed to the disadvantage of the organization, care must be taken. In particular, the cooperative may be required to allow non-members the use of cooperative facilities. Additionally, it is possible that unit train rates themselves may be jeopardized. For these reasons, special legislation is suggested.

Section IV, Potential Cooperative Identification, is the result of an analysis of the population of small mines fitting the 100-500,000 net annual ton production category. It is found that the number of potential cooperatives is relatively small.

They are located in the states of Alabama, Kentucky, Ohio, western Pennsylvania, Tennessee, Virginia and West Virginia.

Section V, Coal Quality Control, discusses the different coal seams mined by the small mines in those areas where cooperatives appear to be indicated. The data for this preliminary study are on a county basis. However, the listed seams are based on individual mine information. To the extent that different seams produce coal of different values, the number of potential cooperatives is reduced. It is possible that an extended analysis of this section, on a mine-by-mine, basis, irrespective of county boundaries, would enlarge the total somewhat. Additionally, analysis of the coals from each seam in each sub-area might show that the coals produced are not dissimilar with respect to the formation of a cooperative.

Section VI, Coal Preparation, is an analysis of the type of machinery used. It is found that there is no definite relationship between the size and the complexity of preparation plants except possibly for the variety of equipment used. It appears that efficient preparation plants can be constructed to process from 200-300 tons/day and upward. The types and sizes of the equipment depend upon the job to be done. The conclusion is partially supported in an article by W. H. Yearroll and F. T. Davis, "The Economics of Small Milling Operations," Mineral Industries Bulletin, Colorado School of Mines, March 1968, where it is concluded that, "No hard and fast rules can be stated

for a lower limit of mill capacity which might still be economically feasible today. In general, however, it is still possible for mills of 500 tons/day and even less, capacity to be not only feasible but, with proper planning and management, even economically attractive."

Section VII, Transportation: Mine to Railhead or Preparation Facility, discusses train, truck, belt conveyor and pneumatic pipelines as a means of transport from the mine to the railhead or preparation plant. It is found that rails are preferred if they already exist. Truck transportation is highly dependent upon both the terrain and the condition of the roads. Belt conveyors are suitable for very short distances and pneumatic pipelines, while they are still experimental, are not subject to problems of terrain. The cost analyses and design parameters are shown. Three appendices on the conveyor belt, the pneumatic pipeline and truck transportation are provided.

Section VIII, Transportation: Unit Trains, discusses loading facilities for unit trains and unit train tariffs. The discussion is limited to the type of facilities needed for unit train operation in the 1.0 million to 1.5 million ton/year class. Several alternate systems are discussed. It is concluded that with respect to unit train tariffs, cost/ton-mile depends primarily upon distance and average annual tonnage. The data, however, are not sufficient to show any strong relationship.

Section IX, Facilities. In this area it is suggested that the major advantage of a cooperative is likely to accrue in the area of finance.

III. LEGAL ASPECTS OF COAL COOPERATIVES

It may be desirable for small coal mines to combine as cooperative associations in order to take advantage of unit train rates. In doing so, the association faces general antitrust laws and also risks the legality of the rate itself. It would be advantageous to have legislation enacted to exempt the association from antitrust laws as has been done with agricultural cooperatives. But, the prospects of such legislation are questionable.

Railroads provide low shipping costs for entities that ship large quantities of commodities using unit trains over the period of a year, with shipments on a regular basis. Unit train operations differ from other trainloads in that the cars remain an integral unit when empty and are returned to predetermined origins for reloading in a shuttle operation.[1] The unit train is of value for coal shipment from both a financial standpoint and physical efficiency. Where feasible, the ICC has adopted rates based on the unit train concept. In the decision of <u>Natural Gas Pipeline Company of America v New York Central Railroad Company</u>, 323 ICC 75, 1964, the use of conditional unit train rates were dependent upon certain yearly and per diem tonnage requirements being met.[2] Rather high load limits are set for the use of unit rates; most coal mines cannot independently take advantage of these rates.

A cooperative corporation is created by a banding together of persons for their common advantage or advancement, financial or otherwise, and is organized for the mutual benefit of its members.[3] Cooperative associations are distinguished from other business structures by the features of democratic control and voting, the distribution of economic benefits on an equal basis or in proporation to the use made of the association facilities, limited return on capital, and the fact of doing most of their business with their own members.[4] Most cooperative associations are incorporated, either under general business laws or under statutes particularly applicable to cooperatives,[5] but incorporation is neither an indispensible nor significant mark of the cooperative.

The problem facing coal mines is not recognition of the cooperative association as a legal entity, the association must be careful to meet the requirements of antitrust laws.* The association must not form an unlawful combination in restraint of trade. Prior to the formation of the association, all of the parties will be shipping coal at either multiple or single car rates. If some operators form a cooperative association and do not allow all operators in the area to benefit from the reduced rates, there may be violations of the Sherman Antitrust

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*It is not feasible to discuss all of the antitrust implications that the cooperative association must consider. The discussion concerns those areas which present the greatest danger to coal mine operators in combination as a cooperative association.

Act. Such a situation may be considered an illegal "bottleneck" agreement denying scarce facilities to competitors. The Sherman Act requires that where facilities cannot practicably be duplicated by would-be competitors, those in possession must share the facilities on fair terms.[7] A leading case dealing with bottleneck agreements is Associated Press v U.S., 326 US 1, 1974.

> It shows that for refusal of entry into an association to constitute illegal restraint of trade there must be some important facility--sometimes a virtual 'bottleneck'--in the association's control, such that, by keeping it exclusive to themselves, the members of the association impose a real handicap on would-be competitors. This handicap need not be fatal; the facility need not be 'indispensable': it is enough that the association's exclusive hold on the scarce resource confers significant competitive advantages on members as against outsiders . . . Finally, it is no defense (SIC) that the members have built up a facility . . . for themselves; new entrants must be allowed to share it on reasonable terms unless it is practicable for them to compete without it.[8]

In applying the Sherman Act, the Supreme Court has read in a "rule of reason."[9] Under the rule of reason, each case is considered under its peculiar fact situation to determine if the restraint imposed is reasonable. Therefore, to avoid any bottleneck problems, the association should probably allow all mines, within the area to be served by the unit train, to join the association. A problem could arise if they wished to use the facility but remain outside the association.

Assuming the valid formation of a cooperative association to take advantage of unit train rates and other advantages, such

an association may jeopardize the legality of unit train rates. In Natural Gas Pipeline, plaintiff raises various issues claiming that unit train rates were discriminatory. The court dismissed the various claims because no specific allegations of discrimination were made. In addition, the court found that the unit train is "naturally different from conventional rail service"[10] and therefore justifies special treatment. The court also found that no competitors of the New York Central Railroad were unduly disadvantaged by the rate. Yet, the establishment of the association may cause discrimination between different sized shipping operations.

In Coal from Illinois, Ind., and Ky. to Illinois and Indiana, 308 ICC 673, 1959, the court discussed possible discrimination in the setting of multiple car rates. The rates were not found to be discriminatory because the circumstances of transportation, as between the traffic of the single car receiver and that of the volume receiver, are substantially different. In other words, multiple car rates are seen as competitive with barges that carry similar loads but not with single car shipments. But, given the cooperative association, the unit rate becomes directly competitive with rates paid by those mines remaining as single car shippers. This new competition may cause unit rates to be found discriminatory under section 2 of the ICC Act.

The association may be able to solve its problems through legislation. The antitrust laws have only limited application

to industries regulated by specific statutes.[11] Regulated industries are not per se exempt from the antitrust laws; rather the antitrust laws are superceded by specific regulatory statutes only to the extent of the repugnancy to them.[12]

An example of exempt cooperative associations are agricultural cooperatives. The Clayton Act includes a provision, codified in 15 USCA § 17, that the antitrust laws are not to be construed to forbid the existence and operation of agricultural organizations instituted for the purpose of mutual help, not having capital stock, and not conducted for profit. And, such organizations or their members will not be held to be illegal combinations in restraints of trade. The Capper-Volstead Act (7 USCA §§ 291-2) was enacted to clarify the exemption for agricultural organizations and to extend it to cooperatives having capital stock. Thus, farmer-producers may organize together, set association policy, fix prices at which their cooperative will sell their produce, and otherwise carry on without violating the antitrust laws.[13]

The exemption granted under the act is limited, and where the monopoly power granted thereunder is unlawfully used, it may give rise to a violation of the Sherman Act sections 2 or 3 or Clayton Act section 7. The Capper-Volstead Act was construed in <u>April v National Cranberry Association</u>, 168 F Supp 919 at 923, 1958.

> I hold that when Capper-Volstead provided that a cooperative and its members were not to be prohibited from "lawfully carrying out the legitimate objects thereof * * *" (to use the language of section 6 of the Clayton Act), at least it did not make lawful purely predatory practices seeking to monopolize, forbidden to an individual corporation, nor did it deprive the victims of such practices effected with monopolizing intent of their private right of action under section 4 of the Clayton Act.[14]

However, where its activities are not predatory in nature nor otherwise illegal under the antitrust laws, a cooperative's proper activities under the Act are not illegal, even though they result in the acquisition of a monopoly position within the market.[15]

While an exemption is desirable, from a political standpoint it is difficult to obtain.[16] Congress is usually reluctant to change antiturst laws because, in doing so, they open a floodgate to industries seeking protection from special problems. While there is no authority for this particular view, the rather limited number of amendments over the long history of the Sherman Act serves as a testament of the resistance to change. A better tactic might be to "squeeze" a regulation of coal associations into some large environmental act.

Section III Footnotes

1. Coal, Ill., Ind., and Western Ky., to Chicago and Oak Creek Power Plant, Wis., 399 ICC Reported 493 at 495, 1971.

2. As an example, the terms of the unit train rates from Natural Gas Pipeline are as follows:

> The freight charges initially collected are to be based on the $1.45 rate, subject to adjustment should the annual tonnage be less than 1,300,000 tons. In that event, charges will be adjusted to the basis of the $1.75 rate, minimum 750,000 tons, unless lower charges result from application of the $1.45 rate at the minimum 1,300,000 tons. If the aggregate annual tonnage falls below 750,000 tons, each carload of coal is subject to rates in effect during such annual period in defendant's Tariff I.C.C. 2323.

3. 18 American Jurisprudence 2nd 261, 1965.

4. Ibid. at 262.

5. Kentucky (§ 272.020) and Illinois (Ch 32 § 304.5) have statutes dealing with the formation of cooperatives generally. Under these statutes coal mines could incorporate as cooperative associations.

   Indiana (§ 15-7-1-3), West Virginia (§ 19-4-2), Ohio (§ 1729.01), and Pennsylvania (Ch 41 § 14 et seq) have specialized statutes allowing the formation of agricultural cooperatives. Therefore, coal mines forming cooperative associations would not be incorporated under the state statutes but would be formed under general business law (as are partnerships).

6. 18 American Jurisprudence 2nd 261, 1965.

7. Neale, The Antitrust Laws of the United States of America, 67, 1970.

8. Ibid. at 68.

9. 54 American Jurisprudence 2d 685, 1971.

10. Natural Gas Pipeline of America v New York Central Railroad Company, 323 ICC 75, 80, 1964.

11. Supra, Note 8 at 778.

12. Ibid.

13. Ibid. at 780.

14. 20 American Law Reports - Federal 924.

15. Ibid., at 935.

16. Special Industry examptions, in some form, now exist for the following (list taken from CCH Trade Regulation Reporter, paragraph 1220).

Agricultural and horticultural organizations	Insurance
Air carriers	Marine insurance associations
Defense and emergency legislation	Marketing agreements
Energy	Motor, rail, and interstate water carriers
Export trade associations	Newspapers
Fishery associations	Small business concerns
	Water carriers.

IV. POTENTIAL COOPERATIVE IDENTIFICATION

Members of potential coal mine cooperatives have been limited to the size class of 100,000 to 500,000 net tons annually. This has been further subdivided into 100-200,000 and 200-500,000 ton classes. The 1973-1974 U.S. population of these small mines is shown in Table IV-1.

Given the requirement that a cooperative be of sufficient size so that unit train loading is feasible, a potential cooperative population has been derived. The number of these cooperatives is shown in Table IV-2. The second requirement for a cooperative is proximity. The data are primarily available on a county basis. Therefore, it is possible that a few additional cooperatives, crossing county and/or state lines could be formed. On the other hand, mileage proximity, if cut by difficult or impossible terrain, may reduce the number of potential cooperatives.

Tables IV-3A through IV-3G show, for the most likely states (see Table IV-1), the distribution of small mines by county. The counties are listed by proximity to each other within coal areas. It will be noted that most counties within a coal state cannot lend support to a cooperative. Where cooperatives are supportable, they are discussed further in Section V.

TABLE IV-1

POPULATION OF SMALL MINES

STATE	MINE SIZE (Annual Tonnage) 100-200,000	200-500,000	TOTAL
Alabama	7	16	23
Arkansas	2	0	2
Colorado	6	5	11
Illinois	0	6	6
Indiana	4	3	7
Iowa	1	1	2
Kansas	1	1	2
Kentucky	49	51	100
Missouri	0	1	1
Montana	0	1	1
New Mexico	0	1	1
North Dakota	2	2	4
Ohio	12	25	37
Oklahoma	5	0	5
Pennsylvania (Anth.)	4	3	7
Pennsylvania (Bit.)	54	49	103
Tennessee	13	8	21
Utah	2	6	8
Virginia	14	20	34
West Virginia	68	70	138
Wyoming	0	1	1
Texas-Alaska-Arizona	0	0	0
Total	244	270	514

TABLE IV-2

POTENTIAL COOPERATIVE POPULATION

STATE	NUMBER OF POTENTIAL COAL COOPERATIVES
Alabama	1
Kentucky	5
Ohio	1
Pennsylvania (Bituminous)	8
Tennessee	1
Virginia	3
West Virginia	10
Total	29

TABLE IV-3A

NUMBER OF SMALL MINES BY COUNTY

ALABAMA

COUNTY	MINE SIZE (Annual Tonnage)		COALFIELD MINED
	100-200,000	200-500,000	
Tuscaloosa	-	2	Worrier
Jefferson	2	6	Worrier
Cullman	1	2	Plateau
Bible	-	2	Not Reported
Marion	2	-	Plateau and Worrier
Blount	2	-	Plateau
Walker	-	4	Worrier
Total	7	16	

TABLE IV-3B

NUMBER OF SMALL MINES BY COUNTY

KENTUCKY

COUNTY	MINE SIZE (Annual Tonnage) 100-200,000	200-500,000
Pike	14	13
Knott	1	4
Breathitt	1	4
Bell	3	1
Hopkins	4	0
Harlan	5	8
Letcher	0	4
Boyd	1	0
MacLean	0	1
Perry	6	5
Floyd	5	1
Pulaski	2	0
Union	0	2
Magoffin	0	2
Christian	1	0
Johnson	2	0
Martin	0	2
McCreary	0	2
Whitley	1	0
Ohio	2	1
Franklin	0	1
Webster	1	0
Total	49	51

TABLE IV-3C

NUMBER OF SMALL MINES BY COUNTY

OHIO

COUNTY	MINE SIZE (Annual Tonnage) 100-200,000	200-500,000
Belmont	1	6
Jefferson	4	6
Harrison	0	4
Vinton	0	1
Muskinggum	1	1
Mahoning	1	0
Holmes	0	1
Tuscaran	0	3
Columbiana	1	0
Carrol	1	0
Coshacton	1	0
Guernsey	1	0
Nobel	0	1
Perry	1	1
Jackson	0	1
Total	12	25

TABLE IV-3D

NUMBER OF SMALL MINES BY COUNTY

PENNSYLVANIA (BITUMINOUS)

COUNTY	MINE SIZE (Annual Tonnage)	
	100-200,000	200-500,000
Blair	1	0
Butler	1	1
Armstrong	4	5
Venango	4	0
Clarion	5	3
Allegheny	1	5
Somerset	6	5
Indiana	3	5
Clearfield	10	11
Cambrian	3	6
Jefferson	1	2
Fayette and Washington	4	3
Westmoreland	2	1
Clinton	1	0
Fayette	2	1
Greene	1	0
Beaver	1	0
Lawrence	1	0
Centre	1	1
Mercer	1	0
Total	53	49

TABLE IV-3E

NUMBER OF SMALL MINES BY COUNTY

TENNESSEE

COUNTY	MINE SIZE (Annual Tonnage)	
	100-200,000	200-500,000
Claiborne	3	1
Campbell	5	3
Scott	1	1
Marion	0	1
Anderson	1	1
Grundy	1	0
Morgan	1	1
Van Buren	1	0
Total	13	8

TABLE IV-3F

NUMBER OF SMALL MINES BY COUNTY

VIRGINIA

COUNTY	MINE SIZE (Annual Tonnage) 100-200,000	200-500,000
Buchanon	7	11
Dickenson	2	3
Wise	3	4
Russell	2	1
Tazewell	0	1
Total	14	20

TABLE IV-3G

NUMBER OF SMALL MINES BY COUNTY

WEST VIRGINIA

COUNTY	MINE SIZE (Annual Tonnage) 100-200,000	200-500,000
Mingo	6	3
Raleigh	4	4
Grant	1	1
Logan	11	6
Boone	7	11
Barbour	2	3
Kanawha	8	9
Taylor	1	0
Randolph	3	0
McDowell	8	6
Mason	0	1
Nicholas	2	10
Wyoming	1	3
Mercer	1	1
Tazewell	0	2
Mineral	4	0
Preston	4	1
Upshur	3	2
Harrison	1	1
Fayette	1	6
Brooke	1	0
Monongalia	0	1
Total	69	71

V. COAL QUALITY CONTROL

In general, coal mines producing from the same seam produce comparable coals. In economic terms it is also possible that coal mined from different seams is comparable with respect to the consumer. It is possible, however, that coals mined from different seams are sufficiently different so that problems arise at the coal preparation facility and in terms of the value of the coal to the individual companies in the cooperative. In terms of a unit train, this may lead to the necessary segregation of the different coals produced by various mines within the cooperative. This is relatively expensive. Finally, if the coals are sufficiently different, even though the mines are in close proximity, it may not be in the best interest of the some of the mines to join a cooperative.

In this section an analysis is made of the seams mined in those states noted in Section IV as the most important with respect to potential cooperatives.

A. Alabama

The two most important coal seams in Alabama from which the mines indicated in Section V produce are the Black Creek and the Mary Lee. Five mines operate in the former and four mines operate in the latter seam. Other seams in the state

include: Lick Creek, Jefferson, America, Platt, Nickelplate, Blue Creek, Thompson, Woodstock, Jones, Alice and Rosa.

In Jefferson County, the only one in the state which appears to be able to support a cooperative, the two mines in the 100-200,000 ton category produce coal from four seams. These are the Lick Creek, Jefferson, Black Creek and Blue Creek seams. The six mines in the 200-500,000 ton category produce coal from a total of seven seams. Three mines produce from the Mary Lee seam, one each from the Lick Creek, Jefferson and Black Creek seams, and one mine produces from all of the Platt, Nickelplate and America seams. Unless it can be shown that these coals are roughly comparable, some difficulty or added expense with respect to a cooperative may be expected.

B. Kentucky

Kentucky coal produced by the mines listed in Section V comes from a wide variety of seams. The number after the name of the seam indicates the number of mines producing from that seam. These include Coalburg (1), Kittannning (1), Hazards No. 4 and 5 (3), Clintwood (2), Cedar Grove Upper and Lower (1), Richardson (1), Elkhorn No. 1 Lower and Upper, No. 2 and No. 3 (11), Pond Creek (1), Thacker (1), Skyline (2), Prater (1), Ryder (1), Red Springs (1), High Splint (2), Mason (2), Harlan (2), Darby (3), Wallane (1), Creech (2), Princess (1), Leatherwood (1), P. Orchard (1), Winefrede (1),

Kellion (1), BCD&E (1). Other seams are listed by number. These include numbers 3, 5A, 6, 7, 8, 9, 10, 11 and 12.

With respect to those counties which appear most conducive to the formation of a cooperative (Pike County, Harlan County and Perry County), the number of seams mined remains large.

In Pike County, twenty-seven mines fit the size category under consideration. Of the fourteen mines in the smaller category, nine different seams are utilized--the most important of which is Elkhorn Nos. 1 and 2, which is mined by three out of the fourteen companies. The others include the Coalberg, Kittanning, No. 4 Hazard, Clintwood, Upper and Lower Cedar Grove and the Richardson seams. For the thirteen larger mines, the most important seam is a Lower Elkhorn which is mined by five of the thirteen companies. The additional seams are the Upper Elkhorn, Clintwood, Pond Creek and Thacker seams.

In Harlan County the five small mines operate in three different seams. Two of them produce from the High Splint, three operate in the Mason and two more operate in the Harlan seams. Of the eight large companies, three produce from the Darby seam, two produce from the Harlan seam, one produces from the Wallane seam and two from the Creech seam. Other seams listed for these eight larger companies include the BCD&E seams.

The eleven mines in Perry County produce from a total of eleven seams. The six small companies produce from the

Leatherwood, the No. 9, the No. 8, the Hazard and the No. 6 seams. The five large companies produce from the No. 9, the No. 10, the No. 11, the Hazard, the No. 4 and the No. 5A-7 seams.

C. Ohio

Ohio coal is produced in fourteen different seams. The numbers in the parentheses indicate the number of mines in our population which produce from each seam. The seams are listed as follows: Pittsburgh No. 8 (12), Pittsburgh No. 11 (4), Pittsburgh No. 12 (1), Waynesburg (1), No. 9 (2), Meighs Creek (2), Sewickley (1), Clarion No. 4A (2), No. 6 (5), No. 5 (2), Brookville No. 4 (1), Middle and Lower Kittanning (4) and Ohio 6 and 7 (1).

Jefferson County Ohio has ten mines which fall into the cooperative size category. The coal is, fortunately, produced from only two seams. Pittsburgh No. 8 is mined by nine companies and Waynesburg is operated by one company.

D. Pennsylvania (Bituminous)

Coal in western Pennsylvania is mined in a total of fifteen seams. The numbers in the parentheses indicate the number of mines in our category which operate in each seam. Kittanning (7), Kittanning Middle (24), Kittanning Lower (7), Kittanning Upper (1), Pittsburgh (13), Freeport (13), Freeport Lower (4),

Freeport Upper (13), Clarion (5), Brookville (7), Seam B (3), Seam C (5), Seam D (5), Seam E (4), Sewickley (1), Waynesburg (4) and Redstone (2).

There are ten counties in western Pennsylvania which could support cooperatives. These are: Armstrong, Clarion, Summerset, Indiana, Clearfield, Cambria, Washington, Fayette, Westmoreland and Greene Counties. Of these, the last four should be grouped together as they all mine a pocket of coal which is both compact and is found within the adjoining borders of each.

In Armstrong County, nine mines are included in the category for potential cooperatives. Of the four small mines, two operate in the Lower Kittanning seam, one in the Upper Kittanning and one in the Pittsburgh seam. Of the five large mines, two operate in the Upper Freeport and one each in the Pittsburgh, Lower Kittanning and the E seams.

In Clarion County, eight mines fit the cooperative category. Of the five small mines, three produce from the Clarion seam, one produces from the Middle and Lower Kittanning seams and one more produces only from the Lower Kittanning seam. The three large mines all produce from each of the following three seams: Freeport, Kittanning and Clarion. It is probable that this area would be quite conducive to a cooperative.

In Summerset County, eleven mines fit the cooperative category. The six small mines produce from ten different seams. Two produce from the Upper Freeport seam, two from

the Lower Pittsburgh, one each from the Sewickley, Lower Kittanning, C, E and Redstone seams, and one mine produces from the B, C and D seams. Of the five large mines, one produces from the Upper Kittanning, one from the Lower Kittanning and one from the Freeport seam.

In Indiana County, eight mines fit the cooperative category. The three small mines produce from two seams. These are the Upper Freeport and the Lower Kittanning. The five large mines produce from the Upper Freeport, the C and E seams and the B seam. The distribution indicates some overlap as, of the three small mines, three produce in the Lower Kittanning and two in the Upper Freeport, while of the larger mines, two produce in the Upper Freeport, one in both the C and E seams, and one in the B seam.

In Clearfield County, twenty-one mines fit the cooperative category. Of the ten small mines, six produce from the Freeport seam, one from the Brookville seam, six from the Kittanning seam, one from both the D and the E seams, and one from both the B and the C seams. Of the eleven large mines, one produces from the D or Moshannon seam, one from the Brookville, three from both the Upper and Lower Freeport seams, and three from both the Lower and Middle Kittanning seams. It would appear that this county could easily support a coal cooperative with respect to the number of seams mined.

In Cambria County, nine mines fit the cooperative category. Of the three small mines, one produces from the C seam, the

other two are not listed. Of the six large mines, one produces in the D seam, four in the Lower Kittanning, and two in the Lower Freeport seam.

Washington, Fayette, Westmoreland and Greene Counties have been grouped together for the reason indicated above. The number of mines fitting the cooperative category in each county are as follows: Washington, seven mines; Fayette, three mines; Westmoreland, three mines; and Greene County, one mine. In Washington County, four small mines operate in two seams. Three in the Waynesburg and one in the Pittsburgh seam. The three large mines all operate in the Pittsburgh seam. In Fayette County, the three mines all operate in all of the Pittsburgh, Waynesburg and Redstone seams. In Westmoreland County, two of the mines operate in both the Pittsburgh and the Upper Freeport seam, the third operates in the D seam. In Greene County, the single mine is not specified. It would appear that this group could form a small cooperative.

E. Tennessee

Coal in Tennessee, based on the mines indicated in Section V, is produced from seven different seams. These are the Red Springs, Red Ash, Rich Mountain, Dean, Sewanee, Pee Wee, and Walnut Mountain seams. The coal is considered suitable for general industrial and domestic purposes and, therefore, may be considered higher quality than most.

Only Campbell County appears to have a sufficient number of mines to support a cooperative. There are eight mines in this county. The five small mines all produce from the Rich Mountain seam. The three large mines produce from the Red Ash and the Pee Wee seams. It would appear that a cooperative could be formed in this area.

F. Virginia

Coal in Virginia is mined from a total of fourteen seams. These include the Sewell, Splash Dam, Pocahontas No. 3, Clintwood, Banner Upper, Banner Lower, High Splint, Faggart, Blair, Lyons, Dorchester, Raven and Hazy seams.

Two counties in Virginia appear capable of supporting cooperatives. These include Buchanan County with eighteen mines and Wise County with seven mines.

In Buchanan County, the seven small mines produce from a total of four seams: the Jewel, Hazy, Splash Dam and the Clintwood seams. Of the eleven large mines, three produce from the Splash Dam, three from Pocahontas No. 3 and three from the Jewel seam. It would appear that there is enough similarity in the coal mined to warrant a cooperative in this county.

In Wise County, the three small mines produce from the Blair, Clintwood and Lyons seams. The four large mines produce from the Upper Banner, the Splash Dam, the Faggart, the High Splint, the Clintwood and the Dorchester seams.

G. West Virginia

In West Virginia, the mines in our population produce from a total of thirty-seven seams. These include the following: twelve from Cedar Grove, four from Coalburg, three from Stockton, three from Alma, two from Chilton, three from Pond Creek, nine from No. 2 Gas, seven from Pocahontas No. 3, five from Pocahontas No. 4, four from Pocahontas No. 6, two from Pocahontas No. 11, one from Pocahontas No. 12, four from Eagle No. 2, three from Bakerstown, three from Powellton, two from Winefrede, sixteen from Five Block, three from Dorothy, one from Williamson, four from Pittsburgh, seven from Pittsburgh and Redstone, one from Redstone, two from Lewiston, one from Hernshaw, eight from Sewell, five from Kittanning, three from Peerless, one from Contour-Conventional-Tioga, two from Elk Lick, five from Freeport, one from Fire Creek, one from Sewickley, one from Red Ash, one from Bradshaw, and one from Hampton.

Seven counties in West Virginia appear capable of supporting cooperatives. These include: Mingo, Raleigh, Logan, Boone, Kanawka, McDowell and Nickolas.

In Mingo County, nine mines fall within our category. The six small mines produce from six different seams. These include the Cedar Grove, Coalburg, Stockton, Pond Creek (from which three produce), Alma and Chilton. The three large mines produce from the Upper Cedar Grove, the No. 2 Gas and the Alma seams.

In Raleigh County, of the eight mines, the four small mines produce from the Pocahontas No. 3, the Pocahontas No. 4 and the Five Block seams. The four large mines produce from the Eagle seam, the No. 2 Gas and the Pocahontas No. 3 seams.

In Logan County, of the seventeen mines in our category, eleven small mines produce from six different seams. These include the Five Block, the Dorothy, the Cedar Grove (from which three produce), the Alma, the Chilton and the Williamson seams. The six large mines produce from the Powellton, Winefrede, Cedar Grove (from which three produce) and the Five Block seams. It would appear that there is enough similarity among these mines to support a cooperative.

In Boone County, of the eighteen mines in our category, the seven small mines produce from a total of four different seams. These include: the Five Block, the No. 2 Gas, the Upper Hampton and the Cedar Grove seams. The eleven large mines produce from the Powellton, Cedar Grove, No. 2 Gas, Five Block (from which eight produce) and the Dorothy seams. It would appear that this county could support a cooperative.

In Kanawka County, of the seventeen mines in our category, the eight small mines produce from a total of five different seams. These include the No. 2 Gas (from which four produce), the No. 2 Eagle, the Five Block, the Stockton and the Coalburg seams. The nine large mines produce from a total of six seams including the Stockton, the Lewiston, the Coalburg, the Hernshaw, the Five Block and the Winefrede seams.

In McDowell County, of the fourteen mines in our category the eight small mines produce from a total of eight different seams. These include the Pocahontas 11 and 12, the Pocahontas 3 and 4, the Pocahontas No. 6, the Red Ash, the Sewell and the Bradshaw seams. The six large mines produce from the Pocahontas 3 and 4 and the Sewell seams.

In Nickolas County, of the twelve mines in our category the two small mines produce from the Sewell and Eagle seams and the ten large mines produce from the Sewell, Eagle, Kittanning (from which four produce), the Peerless and the Contour-Conventional-Tioga seams.

VI. COAL PREPARATION

In 1973, over 60 percent of all coal produced in the U.S. was processed to some extent; 72 percent of underground coal and 42 percent of strip mined coal [6].* The amount of preparation at a particular installation depends upon the amount and quality of both run-of-the-mine coal (ROM) and the desired product. Coal from the mine varies in the size of lumps and in the amount of impurities. These depend upon the in-seam make up of the coal, the amount of roof and bottoms taken, and the type of mining. For example, in surface mining, coal is broken to a greater extent if it has been blasted prior to loading. A loader such as a power shovel or front-end loader might break the coal less than a wheel loader. In general, coal mined underground is broken considerably more than surface mined coal. Size, consistency and even washability and sulfur content are influenced by the type of underground miners, loaders, and transportation equipment used. The Bureau of Mines concludes that conventionally mined coal contains less total fines than coal mined by continuous miners and that borers produce more fines than rippers [2]. Additionally, they point that, in comparison to continuous mining, "Conventional mining yielded a better product in terms of size consistency of ROM and the yields, ash, and sulfur analysis of the washed product" [3].

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*Numbers in brackets refer to references at end of section.

A preparation plant may have a number of functions: breaking, sizing, washing, drying, blending, and loading. In addition, auxiliary services such as dust removal and water clarification may be necessary. The extent of each operation depends upon the quantity and quality of the coal from the mine and the required quality of coal leaving the plant. Coal which is relatively clean when coming from the mine and which is to be used in power generation may require only crushing, whereas coking coal may require extensive cleaning.

The operations of sizing, grinding, washing, and drying are not necessarily distinct or sequential. Modern preparation plants are systems by which coal may be converted at various points or recycled through previous sections.

A. Screening and Picking

Screening is usually accomplished by either vibrator or shaler screens. (Certain types of these are called "grizzlies.") "The modern preparation plant screens are used primarily for sizing for individual cleaning processes and dewatering, rather than to make multiple-sized products as in the past" [6]. As with most mining operations, screening tends to produce fines [5, p. 186]. Some hand picking of coal is being done but, according to Llewellyn [6, p. 428], "The cost of hand picking doomed the practice, not only the labor involved but the space in the plant required to provide adequate width and length for picking two or three sizes." Nevertheless, a number of mines

still list picking tables among their preparations equipment in the Keystone Coal Industry Manual. Some plants also use magnets to pick out bits of iron.

B. Crushing

Coal crushing occurs at practically every preparation plant and, occasionally, in the mine itself. Llewellyn says that the type of crushers at the plant depends upon: "(1) maximum size of feed coal; (2) capacity; (3) desired product size; (4) friability of coal; (5) sulfur balls or middlings; and (6) dusty operation." The ratio of largest size of input coal to average size of product is called the reduction ratio. This ratio partly determines the necessary power input to the crusher. Ratios higher than 10:1 tend to greatly increase power input [16, p. 110].

There are a number of types of crushers. These include roll crushers, rotary breakers, hammer-mills, pick breakers, and jaw crushers. Approximate capacities taken from Coal Age [16] are given in Table VI-1. (It should be noted that tables in Coal Preparation [18, pp. 7-14] give slightly extended capacity ranges.) The most common types of crushers appear to be rotary breakers and roll crushers. Rotary breakers break the coal by repeatedly dropping it on screens until it is small enough to pass through. Roll crushers may have from one to four rollers. Single roll crushers crush the coal between the rotating roller and a breaker

TABLE VI-1

APPROXIMATE CRUSHER CAPACITIES

Single-Roll Crusher Capacities

(Reducing Medium-Hard Bituminous ROM to Indicated Sizes)

Roll Size, Dia x Length (In.)	Capacity, Tph 1½ x 0	2½ x 0	3¾ x 0	5 x 0	6 x 0	8½ x 0	10 x 0
18 x 18	30	75	100	140	—	—	—
24 x 36	105	190	230	275	325	—	—
30 x 45	200	350	400	425	500	—	—
36 x 48	225	360	420	500	600	825	1,000
36 x 54	275	420	500	600	720	1,000	1,200
Hp per tph	1/2	2/9	2/9	1/9	1/9	1/12	1/12

Note: All capacities based on ROM feed with none of the smaller sizes removed.

Heavy-Duty Impact-Type Crusher Capacities

(Reducing Hard Refuse to Indicated Sizes)

Crusher Size, Dia x Length (In.)	Motor Hp	Capacity, Tph 3 x 0	8 x 0
36 x 36	100-150	125	250
36 x 48	100-150	160	300
42 x 48	150-200	180	320
42 x 66	200	240	450

Double-Roll Crusher Capacities

(Reducing Medium-Hard Bituminous ROM to Indicated Sizes)

Roll Size, Dia x Length (In.)	Capacity, Tph 1¼ x 0	1½ x 0	2 x 0	3 x 0	4 x 0	6 x 0	7¼ x 0
18 x 15	25	30	35	45	65	—	—
24 x 20	50	60	65	80	115	180	200
24 x 36	80	100	115	140	200	290	350
30 x 48	140	165	185	235	300	460	575
36 x 54	235	260	310	370	425	545	600
Hp per tph	1/3	1/3	1/3	1/4	1/4	1/8	1/8

Note: All capacities based on ROM feed with none of the smaller sizes removed.

Rotary Breaker Capacities

(Reducing ROM Feed to Minus 1½-In)

Breaker Size, Dia x Length (Ft)	Motor HP	Capacity, TPH
6 × 8	10	75-150
7 × 14	15-20	125-250
9 × 17	40-50	275-450
10½ × 19	60-75	500-750
12 × 22	100-150	1,000-1,500

Note: For rotary breakers equipped with impactors, increase the above capacities by 20%.

Multiple-Roll Two-Stage Crusher Capacities

(Applicable to Both Three- and Four-Roll Units Reducing Medium-Hard Bituminous ROM to Indicated Sizes)

Roll Length (In.)	Motor Hp	Capacity, Tph ½ x 0	¾ x 0	1 x 0	1¼ x 0	1½ x 0
24	30-40	60	90	120	150	180
36	40-50	90	135	180	225	270
48	50-60	120	180	240	300	360
60	60-75	150	225	300	375	450

TABLE VI-1 CONTINUED

Ring-Type Granulator Capacities

(Reducing Medium-Hard Bituminous ROM to Minus ¾-In.)

Rotor Length (In.)	Motor Hp	Capacity, Tph
40	40- 60	75- 120
50	100-125	175- 225
72	200-225	350- 400
96	300-350	600- 700
130	500-600	1,050-1,200

Typical Power Requirements, Coal Breakers and Crushers

Unit	Type Feed	Hp per Tph
Rotary breaker	ROM	⅓
Single-roll crusher	ROM	1/12- ¾
Double-roll crusher	ROM	⅛- ½
Ring granulator	5 x 0	⅓- ½
Hammer mill	3 x 0	1 -2
Impactor	Refuse	½-1
Jaw crusher	Refuse	¾-2

Note: Power requirements will vary with respect to hardness of feed and degree of reduction, and although the above figures are useful for preliminary calculations, the crusher manufacturer should be consulted for final determination based on the specific problem involved.

Swing-Hammer-Pulverizer Capacities

(Secondary Reduction of Medium-Hard Bituminous Coal to Indicated Sizes)

Crusher Size, Dia x Length (In.)	Motor Hp	Capacity, Tph ¼ x 0	1 x 0
20 x 12	12- 20	3	8
24 x 20	30- 40	8	20
36 x 36	75-100	25	90
36 x 60	150-175	50	160
42 x 65	175-250	85	220

Note: Units are available capable of reducing 3- to 1½-in. x 0 feed to 80-85% minus ¼-in. product in capacities to 325 tph, requiring 650-hp drives.

plate. Double roll crushers break the coal between two rotating rollers. Three and four roll crushers crush the coal in two stages.

C. Washing

There are a number of units available for washing coal. For washing coarse coal, dense media washers and jigs are most often used. In dense media washing, the coal is placed in a solution or suspension which has a specific gravity between that of the coal and that of the impurities. In a jig, the impurities are stratified to the bottom of the coal bed by the pulsating action of water supplied through a screen at the bottom of the bed. Jig types include: the Baum, the McNally-Pittsburgh Norton Washer, the McNally-Pittsburgh Mogul Washer, and the Jeffrey jig. Dense media washers are also used to wash fine coal. Concentrating tables, such as the Deister table, which uses a shaking action and a cross flow of water, are also used for fine coal washing. Froth flotation washers and hydrocyclones may also be used. Finally, there are oscillating tables and jigs that use air for the separation medium. While these units create dust, they are more pollution free than wet washers and have the advantage of not wetting the coal.

D. Drying

After washing, drying is necessary to reduce transportation costs, increase heating value, and, sometimes, to prevent freezing. Most dryers are either mechanical or thermal. Vibrating screens, centrifugal dryers, sieve-bend screens, and sometimes classifying cyclones are used for mechanical dewatering. Thermal dryers are more expensive to operate, but are necessary if more than surface moisture is to be removed.

E. Dust Removal

The various operations taking place in a preparation plant create large quantitites of coal dust. There are a number of types of dust collectors, including centrifugal collectors, scrubbers and fabric filters.

F. Blending

A blending bin may be necessary to assure a consistent product from the plant and to assure a consistent input to the plant since the cleaning operations may require a relatively uniform input.

G. Size and Complexity of Preparation Plants

There appears to be no definite relationship between the size and the complexity of preparation plants. In general, the larger plants appear to have a wider variety of equipment than the smaller plants. Table VI-2 is a list of 25 plants from the 1974 Keystone Coal Industry Manual. The list was selected to present some possible equipment configurations. Mines number 21 and 23 show that essentially the same types of equipment can be used both in large and small mines. The Decker Coal Company lists only four Pennsylvania crushers and has a capacity of 32,000 tons per two-shift day. The Theodore de Marsh Company lists picking tables and crushers but produces only 300 tons/day. On the other hand, the Kentucky Mountain Coal Company (No. 19) lists a number of items including heavy media washing and oil treatment but produces only 200 tons/day in one shift. This output was the lowest listed in the Manual. Many of the larger plants are very complex [see 20,8,9,26]. For example, U.S. Steel's Pinnacle plant in West Virginia [9, p. 74] uses magnets, rotary bent sieves, centrifuges, Deister tables, cyclones, froth flotation cells, vacuum filters, and thermal dryers. This plant has a capacity of 1060 tons/hour and is expected to produce 4 million tons of clean coal/year. The flow of coal is complicated and includes a fine coal circuit and a very fine coal circuit.

TABLE VI-2

PREPARATION EQUIPMENT CONFIGURATIONS

MINE, COMPANY	CAPACITY (Tons)	EQUIPMENT	OTHER INFORMATION
1. Ala. By-Products	1,000/day	Jigs, crusher, vibrator and shaker screens.	3"xO washed
2. Ala. By-Products	5,000/day	Heavy density washer, Deister tables.	3"xO washed
3. Coalite, Inc.	750/day	Jigs, driers, dust treatment.	3"xO washed
4. Peabody	20,000/day	Twin-rotary, Bradford breakers, Hewitt-Robbins conveyors.	1973 tonnage: (strip) 3,246,500
5. Pittsburgh & Midway	5,000/day	Crushers and screens.	1 shift; 1973 tonnage: 1,076,120
6. AMAX	4,700/day	One link-belt and one McNally-Norton washery; crushers; vibrator and shaker screens, loading booms; three centrifuges; oil type dust treatment; freeze-proof treatment.	1973 tonnage: 921,015
7. AMAX	12,000/day	McNally Pittsburgh Preparation Plant with jig washers.	1973 tonnage: 2,942,035
8. Monterey Coal Co.	14,000/day	10x24 foot McNally rotary breaker, 1800 tph for reduction to 6x10, fed at a rate of 1000 tph; two McNally mogul washers; McNally rewash box, dewatered on vibrating screens.	1973 tonnage: 2,695,000
9. Peabody	15,500/day	R&S jig washer, shaker screens, loading booms; oil type dust treatment.	1973 tonnage: 4,147,069
10. Peabody	2,700/day	Baum jigs, vibrators, centrifugals.	1973 tonnage: 309,892
11. AMAX	8,000/day	Breaker: coal to top size 1-1/4".	For electric utilities. 1973 tonnage: 2,096,526
12. Peabody	6,000/day	McNally-Pittsburgh Preparation Plant.	1973 tonnage: 3,043,781

TABLE VI-2 Continued

	MINE, COMPANY	CAPACITY (Tons)	EQUIPMENT	OTHER INFORMATION
13.	Beard Coal Co.	500/day	Vibrator screens, loading booms	Ships 1-1/4"xO and 6"x2
14.	Clemens Coal Co.	1,800/day	Jeffrey Baum jig washer.	Strip
15.	Apache Coal Co.	100/hour 800/day	Hydro-separator from 3/4" to 5"; double roll crushers, picking tables, loading booms, oil treatment, dust proofing and screens.	1973 tonnage: 33,241
16.	Bane Mining Co.	200/hour 1,600/day	Gundlach crusher, shaker, tables.	1973 tonnage: 321,000
17.	Big Four Coal Corp.	350/day	Standard tipple, crusher, shaker screens, loading booms, picking tables.	
18.	Dixie Fuel Co.	1,200/day	One Jeffrey 30x30 crusher, one Gundlach 36 DA, two diamond vibrators.	
19.	Kentucky Mountain Coal Co.	200/day	Heavy media, oil treatment, vibrator and shaker screens, loading booms, magnets, picking tables.	Deep, one shift.
20.	TCH Coal Co.	3,000/day	Heavy media washer.	
21.	Decker Coal Co.	2,000/hour 32,000/day	Four Pennsylvania crushers	Ships 2"xO. 1973 tonnage: 4,150,000
22.	Dudek Coal Mining Co.	800/day 100/hour	McClanahan crusher	
23.	Theodore de Marsh Coal Mine	300/day	Picking tables, crushers.	
24.	Moshannon Falls Mining Co.	75/hour	One Williams & Green picking table, one shaker screen, one double roll crusher.	Strip 1 shift.
25.	Douglas Pocahontas Coal Corp.	1,000/day	Jeffrey jig.	

Mines of Table VI-2

1. Bradford Preparation Plant (Ala)
2. Maxine Mine (Ala)
3. Brilliant No. 1 and 2 Mines (Ala)
4. Black Mesa Mine (Ariz)
5. Edna Mine (Ark)
6. Delta Mine (Ill)
7. Leahy Mine (Ill)
8. No. 1 Mine (Ill)
9. No. 10 Mine (Ill)
10. Eagle Mine (Ill)
11. Wright Mine (Ind)
12. Universal Mine (Ind)
13. Beard Mine (Iowa)
14. Clemens #22 Mine (Kan)
15. Mine #1 (Ken)
16. Bane Mine (Ken)
17. Premium Mine (Ken)
18. Dixie Mine (Ken)
19. Mine #7 (Ken)
20. Mine #1 (Ken)
21. No. 1 Mine (Mont)
22. Dudek No. 2 Mine (Ohio)
23. Theodore de Marsh Mine (Penn)
24. Mt. Carmel #2 Mine (Penn)
25. Mines #8,9,10,11,16,17 (West Va)

Table VI-3 gives estimates of the number of plants of various sizes tabulated from the Keystone Coal Industry Manual. Because of ambiguities in the listings and possible omissions, the figures are only approximate. Briefly, the percentages of 640 plants of sizes between 0 and 7,500 tons/day are:

Tons/Day		
More than	but Less than	Percent
0	500	5.8
500	1,500	24.1
1,500	2,500	19.5
2,500	3,500	9.5
3,500	4,500	8.8
4,500	5,500	7.7
5,500	6,500	5.0
6,500	7,500	4.8
7,500	--	14.8

Kentucky, Virginia, and West Virginia tend toward smaller sizes whereas Illinois' plants tend to be large. Pennsylvania has plants of all sizes. Table VI-4, taken from Coal Age, lists the hourly capacities of new plants from 1968 to 1970. The smallest of these are about 15 to 20 tons/hour. They tend to have little equipment. Table VI-5 gives yearly capacities or output of Illinois preparation plants. Table VI-1 taken from Coal Age [16] gives capacities of various types of crushers. Roll crushers have capacities of from 25 to 1,200 tons/hour and rotary breakers have capacities of from 75 to 1,500 tons/hour. Washers tend to

TABLE VI-3

	Tons/Day								
At Least:	0	500	1500	2500	3500	4500	5500	6500	7500
But Less Than:	500	1500	2500	3500	4500	5500	6500	7500	& up
Alabama	1	5	6	5	0	4	2	0	2
Arizona	0	0	0	0	0	0	0	0	1
Arkansas	0	1	0	0	0	0	0	0	0
Colorado	0	1	4	2	0	2	1	0	0
Illinois	1	0	2	1	2	2	3	9	15
Indiana	0	0	0	0	2	3	2	0	5
Iowa	0	2	0	0	0	0	0	0	0
Kansas	0	0	1	0	0	1	0	0	0
Kentucky	3	38	26	7	12	7	3	6	16
Maryland	0	0	2	0	0	0	0	0	0
Missouri	0	0	0	1	1	0	0	0	0
Montana	0	0	1	0	0	0	0	0	3
New Mexico	0	0	0	0	2	0	0	0	0
North Dakota	0	2	0	1	0	0	1	0	2
Ohio	3	9	6	2	1	2	2	3	9
Oklahoma	0	2	0	0	0	0	0	0	0
Pennsylvania (Anthracite)	4	5	2	0	0	0	0	0	0
Pennsylvania (Bituminous)	10	24	13	10	10	9	2	4	11
Tennessee	3	6	3	0	0	0	0	1	0
Utah	0	2	0	1	2	0	0	0	1
Virginia	6	24	17	9	6	2	1	1	8
Washington	0	0	0	0	0	0	0	0	1
West Virginia	6	31	42	22	18	16	14	7	19
Wyoming	0	2	0	0	0	1	1	0	2
Total	37	154	125	61	56	49	32	31	95
Percent of Total	5.8	24.1	19.5	9.5	8.8	7.7	5.0	4.8	14.8

Total All Mines: 640

TABLE VI-4

HOURLY CAPACITIES OF NEW PLANTS
FROM 1968 TO 1970

1968:

Coal company	Plant location	Capacity, TPH	Preparation equipment
Amherst Coal Co.	Yolyn, W. Va.	700	Daniels[1]
Badger Coal Co.	Phillipi, W. Va.	...	Heyl & Patterson[2]
Barnes & Tucker Co.	Barnesboro, Pa.	150	Roberts & Schaefer[3]
Bell & Zoller Coal Co.	Murdock, Ill.	155	McNally Pittsburg[3]
Black Diamond Coal Mining Co.	W. Blocton, Ala.	300	Daniels[4]
			Deister Concentrator[4]
Boone County Coal Corp.	Sharples, W. Va.	80	Daniels[5]
			Elmco[5]
C & J Coal Co.	Middlesboro, Ky.	100	Arthur G. McKee[6]
Cannelton Coal Co.	Cannelton, W. Va.	100	J. O. Lively[7]
			Centr. & Mech Inds.[7]
Canterbury Coal Co.	Avonmore, Pa.	200	Irvin-McKelvy[8]
Carbon Fuel Co.	Carbon, W. Va.	...	Heyl & Patterson[10]
Clinchfield Coal Co.	Dante, Va.	...	Heyl & Patterson[11]
Consolidation Coal Co.	Cresap, W. Va.	1,000	Galis[12]
			Daniels[12]
			Arthur G. McKee[12]
Duquesne Light Co.	Greensboro, Pa.	...	Heyl & Patterson[13]
Florence Mining Co.	Seward, Pa.	1,500	Galis[14]
	Seward, Pa. (2)	600	Daniels[14]
	Seward, Pa. (14)	250	Industrial Contracting[14]
Hanna Coal Co.	Georgetown, Ohio	...	Heyl & Patterson[14]
Harmar Coal Co.	Harmarville, Pa.	...	Heyl & Patterson[15]
Helen Mining Co.	Coral, Pa.	1,400	Industrial Contracting[16]
			Daniels[16]
Helvetia Mining Co.	Indiana, Pa.	...	Irvin-McKelvy[17]
			Pennsylvania Crusher[17]
Howe Coal Co.	Heavener, Okla.	500	Roberts & Schaefer[18]
			Arthur G. McKee[18]
Island Creek Coal Co.	Morganfield, Ky.	1,000	J. O. Lively[19]
			Daniels[19]
			Centr. & Mech. Inds.[19]
			Heyl & Patterson[19]
	Hamilton, Va. (10)	250	Deister Concentrator[19]
Itmann Coal Co.	Itmann, W. Va.	900	Daniels[18]
	Itmann, W. Va.	...	Heyl & Patterson[18]
	Itmann, W. Va. (15)	60	Arthur G. McKee[18]
James Coal Co.	Starford, Pa.	...	Irvin-McKelvy[21]
Johnstown Coal & Coke Co.	Glen Campbell, Pa.	75	Wilferd L. Roller[22]
Juanita Coal & Coke Co.	Cameo, Colo.	75	Ronald L. Phillips[23]
Kentland Elkhorn Coal Co.	Dunlap, Ky.	...	Heyl & Patterson[24]
	Dunlap, Ky.[3]	50	Deister Concentrator[24]
Kentucky Carbon Corp.	Phelps, Ky.	100	J. O. Lively[25]
			Bird Machine[25]
Mears Coal Co.	Dixonville, Pa.	150	Wilfred L. Roller[26]
Mountaineer Coal Co. Div.	Farmington, W. Va.	1,000	Industrial Contracting[27]
North Cambria Fuel Co.	Spangler, Pa.	250	Irvin-McKelvy[28]
			First Colony[28]
Olga Coal Co.	Caretta, W. Va. (20)	50	Arthur G. McKee[29]
Omar Mining Co.	Madison, W. Va.	200	Daniels[29]
P. B. S. Coals, Inc.	Central City, Pa.	150	Irvin-McKelvy[31]
Peabody Coal Co.	Shawneetown, Ill.	4,000	Powered Equipment[32]
	Shawneetown, Ill.	3,000	Powered Equipment[32]
	Freeburg, Ill.	...	Heyl & Patterson[2]
	Clinton, Mo.	...	Heyl & Patterson[32]

TABLE VI-4 CONTINUED

Coal company	Plant location	Capacity, TPH	Preparation equipment
Pennsylvania State University	Hollybrook, Pa.	...	Heyl & Patterson[33]
Pittsburgh Coal Co. Div.	Renton, Pa.	...	Heyl & Patterson[19]
Pocahontas Empire Coal Corp.	Jacobs Fork, W. Va.	300	Daniels[14]
Pocahontas Fuel Co. Div.	Pineville, W. Va.	1,200	J. O. Lively[31]
			Ruttman[31]
		560	Heyl & Patterson[34]
			Daniels[34]
			Arthur G. McKee[35]
			Elmco[35]
	McComas, W. Va.	...	Daniels[37]
			Heyl & Patterson[37]
			Elmco[37]
	Beckley, W. Va.	560	Dravo[38]
			J. O. Lively[38]
			McNally Pittsburg[38]
			Deister Concentrator[38]
			Arthur G. McKee[38]
Premium Coal Co.	Wellington, Utah	165	Jeffrey[39]
Pratt Coal Co.	Birminghamport, Ala.[8]	...	Deister Concentrator[33]
Race Fork Coal Co.	Hurley, Va.	...	Jeffrey[39]
			Persingers Supply[39]
Republic Steel Corp.	Fredericktown, Pa.	...	Heyl & Patterson[40]
Sigmon Construction Co.	Coalgood, Ky.	160	Arthur G. McKee[6]
Stahlman Coal Co.	Corsica, Pa.	...	Heyl & Patterson[19]
Truax-Traer Coal Co. Div.	Norris, Ill.	1,000	J. O. Lively[41]
			McNally Pittsburg[41]
			Arthur G. McKee[41]
			Centr. & Mech. Inds.[41]
Union Carbide Corp.	Bell Creek, W. Va.	3,000	Galis[41]
United States Steel Corp.	Wellington, Utah (2)	25	Arthur G. McKee[18]
	Wellington, Utah	...	Heyl & Patterson[18]
	Alpheus, W. Va.	...	Heyl & Patterson[13]
	Corbin, Ky. (6)	200	Deister Concentrator[13]
Valley Camp Coal Co.	Short Creek, W. Va.	212	Link-Belt[43]
Webster County Coal Co.	Clay, Ky.	500	Powered Equipment[44]
Westmoreland Coal Co.	Appalachia, Va.	600	J. O. Lively[45]
Winding Gulf Coals	Helen, W. Va.	100	J. O. Lively[46]
Youghiogheny & Ohio Coal Co.	Beallsville, Ohio	1,000	McNally Pittsburg[47]
			Link-Belt[48]
	Cadiz, Ohio	600	McNally Pittsburg[49]

Anthracite

Coal company	Plant location	Capacity, TPH	Preparation equipment
Blaschak Bros.	Mahanoy City, Pa.	15	Arthur G. McKee[11]
Greenwood Mining Co.	Lansford, Pa.	300	Arthur G. McKee[11]
Legal Coal Co.	Tamaqua, Pa. (2)	...	Deister Concentrator[9]

Canada—by U.S. manufacturers

Coal company	Plant location	Capacity, TPH	Preparation equipment
Coleman Collieries, Ltd.	Coleman, Alta.	...	Heyl & Patterson[14]
Consolidation Coal Co. of Canada	Luscar, Alta.	440	McNally Pittsburg[11]
			Arthur G. McKee[11]
Kaiser Steel Co.	Fernie, B. C.	1,000	Roberts & Schaefer[13]
			Link-Belt[13]
			Arthur G. McKee[13]

TABLE VI-4 CONTINUED

1969:

Coal company	Plant location	Capacity, tph	Preparation equipment
Ayrshire Coal Co.	Perry County, Ill.	1,200	McNally-Pittsburg[1]
Barnes & Tucker Co.	Barnesboro, Pa.	1,500	J. O. Lively[2]; Jeffrey Mfg. Co.[3]; Cent. & Mech. Inds.[4]; Stone Conveyor Co.[5]
Beaver Creek Consolidated Coal Co.	Knott County, Ky.	650	Heyl & Patterson[6]
Bethlehem Steel Corp.	Jenkins, Ky.	58	McNally-Pittsburgh[6]; Arthur G. McKee[6]
Bishop Coal Co.	Bishop, Va.	408	Link-Belt Div., FMC[7]
Boone County Coal Corp.	Moncio, W. Va.	280	Daniels[8]
Buckeye Coal Co.	Nemacolin, Pa.	....	Heyl & Patterson[9]
Burgess Company, A.E.	Tarrant City, Ala.	1,500	McNally-Pittsburg[10]
C & K Coal Co.	Clarion, Pa.	150	Irvin-McKelvy[11]
Cannelton Coal Co.	Cannelton, W. Va. (4)	16	J. O. Lively[6]; Arthur G. McKee[6]
	Cannelton, W. Va.	60	J. O. Lively[12]; Cent. & Mech. Inds.[13]
	Cannelton, W. Va.	600	J. O. Lively[1,13]
	Cannelton, W. Va.	....	Heyl & Patterson[9]
Carbon Fuel Co.	Winifrede, W. Va.	550	J. O. Lively[2,14]; Arthur G. McKee[14]; Deister Concentrator Co.[15]; Link-Belt Div., FMC[14]; Heyl & Patterson[14]
Cimarron Coal Co.	Madisonville, Ky.	3,000	Powered Equipment Inc.[6]
Clifftop Smokeless Coal Co. ..	Clifftop, W. Va.	25	J. O. Lively[6]; Diester Concentrator Co.[6]
Clinchfield Coal Co.	Feds Creek, Ky.	156	Dravo[7]; Link-Belt Div., FMC[7]
	Jewell Valley, Va.	60	Arthur G. McKee[6]; Industrial Contracting[6]
	Whitewood, Va.	51	Arthur G. McKee[6]; McNally-Pittsburg[6]
Dash Coal Co.	Gilbert, W. Va.	150	Persinger Supply Co.[17]; Jeffrey Mfg. Co.[17]
Freeman Coal Corp.	Waltonville, Ill.	512	Roberts & Schaefer[7]; Link-Belt Div., FMC[7]
	Waltonville, Ill.	....	Heyl & Patterson[18]
Howe Coal Co.	Howe, Okla.	375	Roberts & Schaefer[7]; Link-Belt Div., FMC[7]
Island Creek Coal Co.	Providence, Ky.	1,000	McNally-Pittsburg[19]
		1,000	Powered Equipment[19]
	Madisonville, Ky.	500	J. O. Lively[2,21]; Daniels[21]; Cent. & Mech. Inds.[21]; Heyl & Patterson[21]
	Morganfield, Ky.	....	Heyl & Patterson[9]
	E. Morganfield, Ky.	310	Daniels[22]
	Pond Fork, W. Va.	500	J. O. Lively[23]; Daniels[23]; Cent. & Mech. Inds.[23]
		550	J. O. Lively[24]
	Vansant, Va.	625	McNally-Pittsburg[2,25]; Arthur G. McKee[25]; Deister Concentrator Co.[25]
	Wheelwright, Ky.	189	McNally-Pittsburg[26]; Deister Concentrator Co.[26]

TABLE VI-4 CONTINUED

Coal company	Plant location	Capacity, tph	Preparation equipment
...well Ridge Coal Corp.	Whitewood, Va.	400	McNally-Pittsburg[27]; Daniels[27]
...aser Steel Corp.	Sunnyside, Utah	200	Arthur G. McKee[28]
...terry Coal Co.	Carlinville, Ill.	1,000	McNally-Pittsburg[29]
... River Co.	Summerlee, W. Va.	....	J. O. Lively[30]
...a Coal Co.	Caretta, W. Va.	700	McNally-Pittsburg[31]
...eat Mining Co.	Madison, W. Va.	250	Daniels[32]
...cific Power & Light Co. ..	Spokane, Wash. (2)	1,400	Roberts & Schaefer[33]; Jeffrey Mfg. Co.[33]
Peabody Coal Co.	Shawneetown, Ill.	4,000	Powered Equipment Inc.[34]
	Shawneetown, Ill.	3,000	Powered Equipment Inc.[35]
	Universal, Ind.	3,000	Powered Equipment Inc.[36]
	Universal, Ind.	1,300	McNally-Pittsburg[37]
Pittsburg & Midway Coal Mining Co.	Barton County, Mo.	600	McNally-Pittsburg[38]
Pocahontas Fuel Co.	Pineville, W. Va. (2)	250	Daniels[39]
Premium Coal Co.	Soldier Canyon, Utah	150	Jeffrey Mfg. Co.[40]
Republic Steel Corp.	Elkhorn City, Ky.	....	Heyl & Patterson[9]
Sahara Coal Co.	Harrisburg, Ill. (2)	....	Heyl & Patterson[41]
	Harrisburg, Ill. (2)	2,400	Roberts & Schaefer[42]; McNally-Pittsburg[42]
Solar Fuel Co.	Hooversville, Pa.	225	McNally-Pittsburg[43]
Southern Electric Generating Co.	Parrish, Ala.	35	Daniels[44]
		3,000	McNally-Pittsburg[45]
Tennessee Valley Authority	Cumberland City, Tenn. (4)	....	Heyl & Patterson[46]
United Pocahontas Coal Co. ..	Crumpler, W. Va.	15	James W. Miller & Assoc.[47]; Eimco Corp.[47]
U.S. Steel Corp.	Gary, W. Va.	1,200	Kanawha Mfg. Co.[48]
		625	Kanawha Mfg. Co.
		170	Arthur G. McKee[49]
	Pineville, W. Va.	400	Allen & Garcia[50]; Daniels[52]
Waterloo Coal Co.	Oak Hill, Ohio	....	Dunfee Machine Shop[53]
Westmoreland Coal Co.	Clothier, W. Va.	....	Heyl & Patterson[55]
	Clothier, W. Va.	....	Heyl & Patterson[56]
	Eccles, W. Va.	250	J. O. Lively[2,51]; Arthur G. McKee[51]; Deister Concentrator Co.[51]; Link-Belt Div., FMC[51]; Heyl & Patterson[51]
Winding Gulf Coals, Inc.	Clifftop, W. Va.	200	J. O. Lively[2,52]; Link-Belt Div., FMC[52]; Deister Concentrator Co.[52]
	Maben, W. Va.	....	J. O. Lively[53]

Anthracite

Coal company	Plant location	Capacity, tph	Preparation equipment
...enwood Mining Co.	Tamaqua, Pa.	150	Arthur G. McKee[55]
...audt's Ferry Preparation Co.	Syferts Dam, Pa.	100	Deister Concentrator Co.[56]

TABLE VI-4 CONTINUED

1970:

Coal company	Plant location	Capacity, tph	Preparation equipment
Alabama Power Co.	Gergas, Ala.	1,600	McNally Pittsburg [1,2]
Allegheny Mining Corp.	Mt. Storm W. Va.	200	Irvin-McKelvy[1,3]
Allegheny River Mining Co.	Kittanning, Pa.	600	Irvin-McKelvy[4]
Amherst Coal Co.	Logan, W. Va.	300	Bird Machine[5]
	Slagle, W. Va.	400	Dravo[1,6]
			Heyl & Patterson[6]
Arch Minerals	Fablus, Ala.	500	McNally Pittsburg [1,7]
	Belle Rive, Ill.	800	McNally Pittsburg [8]
Armco Steel Corp.	Montcoal, W. Va.	...	Kanawha[9]
	Twilight, W. VA.	...	
Badger Coal Co.	Philippi, W. Va.	...	Daniels[10]
Barnes & Tucker Co.	Barnesboro, Pa.	...	Heyl & Patterson[11]
	Carrolltown, Pa.	250	J.O. Lively[12]
Beaver Creek Consolidated Coal Co.	Wayland, Ky.	650	Heyl & Patterson[13]
			McNally Pittsburg [13]
			Deister[13]
Bethlehem Mines Corp.	Jenkins, Ky.	...	Heyl & Patterson[14]
	Kayford, W. Va.	650	McNally Pittsburg [1,15]
			Heyl&Patterson[15]
Boone County Coal Corp.	Moncio, W. Va.	...	Heyl & Patterson[16]
	Sharples, W. Va.	250	Daniels[17]
			Deister[17]
Buffalo Mining Co.	Kermit, W. Va.	...	Daniels[18]
Cannelton Coal Co.	Cannelton, W. VA.	...	Daniels[19]
Carbon Fuel Co.	Carbon, W. Va.	...	Galis[20]
	Wevaco, W. Va.	324	McNally Pittsburg [22]
			Galis[22]
			Heyl & Patterson[22]
	Winefrede, W. Va.	...	Galis[1,23]
C&K Coal Co.	Clarion, Pa.	400	Irvin McKelvy[24]
Central Coal Co.	New Haven, W. Va.	...	McNally Pittsburg [25]
			Bird Machine[25]
CF&I Steel Corp.	Pueblo, Colo.	...	Roberts & Schaefer[26]
Clinchfield Coal Co.	Feds Creek, Ky.	200	Dravo[27,1]
			Bird[27]
	Mouthcard, Ky.	...	Dravo[1,28]
	Clinchfield, Va.	20	Bird[21]
Consolidation Coal Co.	Beckley, W. Va.	...	Heyl & Patterson[14]
	Raleigh, W. Va.	20	Bird[29]
Eastern Associated Coal Corp.	Affinity, W. Va.	400	Roberts & Schaefer[30]
	Boone County, W. VA.	...	Roberts & Schaefer [64]
Eastern Coal Corp.	Stone, Ky.	25	Dravo[29]
			Bird Machine[21]
Enos Coal Corp.	Enosville, Ind.	...	Heyl & Patterson[14]
	Oakland City, Ind.	...	Roberts & Schaefer[31]
Feds Creek Coal Co.	Dunlap, Ky.	200	Zeni-McKinney-Williams[32]
			Deister[32]
	Pike County, Ky.	...	Dravo[1,33]

TABLE VI-4 CONTINUED

Coal company	Plant location	Capacity, tph	Preparation equipment
Fording Coal Ltd.	British Columbia, Cana.	700	Bird Machine[4]
Helen Mining Co.	Seward, Pa.	75	Irvin-McKelvy[35]
Hill Gail Coal Co. Inc.	Whitesburg, Ky.	350	Powered Equipment Inc[1,36]
Island Creek Coal Co.	East Morganfield, Ky.	...	J.O. Lively [33]
	Madisonville, Ky.	1,000	Powered Equipment Inc[37]
	Tire Hill, Pa.	...	Irvin-McKelvy[38]
	Buchanan County, Va.	625	McNally Pittsburg [1,39]
	Vansant, Va.	...	McNally Pittsburg [40]
	Matoaka, W. Va.	...	Daniels[41]
			Deister[41]
	Werth, W. Va.	90	Bird Machine[29]
Jewell Ridge Coal Corp.	Jewell Valley, Va.	500	McNally Pittsburg [1,42]
			Daniels[42]
Kanawha Coal Co.	Ashford, W. Va.	400	Roberts & Schaefer[43]
Kentland-Elkhorn Coal Co.	Dunlap, Ky.	...	Heyl & Patterson[14]
Martin County Coal Corp.	Ines, Ky.	1,000	Daniels[1,44]
			Deister[44]
			Heyl & Patterson[44]
Moffat Coal Co.	Murdoch, Ill.	70	Bird Machine[29]
North American Coal Co.	Powhatan Pt., O. (Q)	600	J.O. Lively[1,45]
	Powhatan Pt., O. (N)	1,200	
Old Ben Coal Corp.	Sesser, Ill	...	Roberts & Schaefer[46]
Omar Mining Co.	Madison, W. Va.	...	Heyl & Patterson[47]
P.B.S. Coals, Inc.	Mercersburg, Pa.	200	Irvin-McKelvy[1,3]
P&N Coal Co.	Punxsutawney, Pa.	250	Irvin-McKelvy[48]
Peabody Coal Co.	Freeburg, Ill.	...	Heyl & Patterson[14]
	Camp Breckenridge, Ky.	3,000	Powered Equipment Inc[49]
			Heyl & Patterson[49]
	Madisonville, Ky.	600	McNally Pittsburg [50]
Pittsburgh Coal Co.	Renton, Pa.	...	Heyl & Patterson[51]
Pocahontas Fuel Co.	Matoaka, W. Va.	50	Daniels[1,52]
			Deister[53]
	McComas, W. Va.	75	Daniels[1,53]
			Deister[53]
Pounding Mill Coal Co.	McCarr, Ky.	150	Jeffrey[54]
Ranger Fuel Corp.	Bolt, W. Va.	250	J.O. Lively [1,66]
Royalty Smokeless	Premier, W. Va.	200	McNally Pittsburg [56]
			Daniels[56]
Rushton Mining Co.	Phillipsburg, Pa.	350	J.O. Lively[1,57]
South East Coal Sales Co. Inc.	Whitesburg, Ky.	350	Powered Equipment Inc[58]
Tennessee Consolidated Coal.	Jasper, Tenn.	400	Roberts & Schaefer[59]
United Electric Coal Cos.	DuQuoin, Ill.	250	Bird Machine [65]
United Pocahontas Coal Co.	Crumpler, W. Va.	25	Bird Machine[21]
U.S. Steel Corp.	Lynch, Ky.	...	Galis[60]
			Heyl & Patterson[60]
	Wyoming County, W.Va.	600	Allen & Garcia[61]
			Deister[61]
	Pineville, W. Va.	594	Allen & Garcia[62]
			McNally Pittsburg [62]
Winding Gulf Coals Inc.	Eccles, W. Va.	...	J.O. Lively[63]

TABLE VI-5

ILLINOIS

II PRODUCTION — TABLE 12 —
SPECIAL PREPARATION PLANTS

Name of operator	Address	Type and make of installation	Tonnage prepared or capacity of plant
Amax Coal Co., Delta	Marion	Mechanical Jig Type	921,015
Amax Coal Co., Leahy	Campbell Hill	Crushing Jig Washing	2,942,035
Amax Coal Co., Sun Spot	Vermont	Heavy Media Fluid	832,631
Consolidation Coal Co., #2	DuQuoin	Crushed and Washed	1,431,594
Consolidation Coal Co., #3	Sparta	Jig Washing	1,397,282
Consolidation Coal Co., #4	Cutler	Jig Washing	745,196
Consolidation Coal Co., Norris	Norris	J. O. Lively — Washed & Centrifical Dried	1,050,071
Freeman Coal Mining Corp. #3	Waltonville	Deduster — Heavy Media, Dry Cleaner	2,207,429
Freeman Coal Mining Corp. #4	Marion	Roberts & Schaefer — Heavy Media	1,254,290
Freeman Coal Mining Corp. #5	Waltonville	Heavy Media Washed	1,829,970
Harrisburg Coal Co.	Marion	Deister Table Washer	60,447
Hazel Dell Coal Corp.	New Windsor	Air Washer	17,292
Inland Steel Co.	Sesser	Modern Preparation Plant	2,593,482
Midland Coal Co., Allendale	Wyoming	All Jig Washed	379,038
Midland Coal Co., Edwards	Edwards	McNally	349,119
Midland Coal Co., Elm #1	Trivoli	McNally Pittsburg	924,127
Midland Coal Co., Mecco	Victoria	McNally Wash Boxes	1,015,777
Monterey Coal Co.	Carlinville	Baum Jig Type	2,601,505
Old Ben Coal Corp. #21	Sesser	Mozul Jig Type Media Cyclones	2,004,279
Old Ben Coal Corp. #26	Sesser	Mozul Jig Type Super Air Flow	2,100,316
Peabody Coal Co. #10	Pawnee	Jig Washer	4,147,074
Peabody Coal Co., Eagle #2	Shawneetown	Cyclone Plant	1,021,522
Peabody Coal Co., Eagle Strip	Shawneetown	McNally Pittsburg	303,875
Peabody Coal Co., Northern	So. Wilmington	McNally Pittsburg	414,100
Peabody Coal Co., River King U.G.	Freeburg	McNally Pittsburg	2,279,504
Peabody Coal Co., River King Strip	Lenzburg	McNally Pittsburg	4,296,653
Peabody Coal Co., Will Scarlet	Stonefort	Link Belt Plant	859,380
Sahara Coal Co., Inc. #6, 20, 21	Harrisburg	Entire Production Washed at Central Plant	2,278,135
Southwestern Ill. Coal Corp., Captain	Percy	McNally Pittsburg Washer	4,451,313
Southwestern Ill. Coal Corp., Streamline	Percy	McNally Washery	1,445,733
The United Electric Coal Cos. #11	DuQuoin	Koppers Rheolaveur	1,630,003
The United Electric Coal Cos. #17	Canton	Nelco Heavy Media	1,253,473
The United Electric Coal Cos. #27	Cuba	Roberts & Schaefer Heavy Media	461,323
Vi-Lar Coal Co.		Belknap Washer & Air Table	422
Zeigler Coal Co. #2	Sparta	McNally Pittsburg — Wet Wash	843,114
Zeigler Coal Co., Murdock	Murdock	McNally #223	1,531,716
Zeigler Coal Co., #4	Johnston City	McNally Vissac Drying Equipment	423,211

From 1973 Annual Coal, Oil, and Gas Report, Illinois Department of Mines and Minerals.

be somewhat smaller. Some examples are given in Table VI-6. Capacities of dewatering screens are given in Table VI-7 [9, pp. 12-8 to 12-11].

It appears that efficient preparation plants can be constructed to process from 200 to 300 tons/day and upward. The types and sizes will depend upon the job to be done. In 1965, Reynolds [25] suggested development of "unitized" plants which would (1) take ROM sizes of 6" top size, (2) clean coal greater than 1/4"x0, (3) provide crushing facilities, and (4) assemble and disassemble easily. He advised that these plants be built in 150 or 250 or 350 tons/hour sizes. The cost of such a plant in 1965 would be about $200,000 to $350,000. Given the available sizes of equipment, such plants should be feasible.

TABLE VI-6

EXAMPLES OF SIZES OF WASHERS

TYPE	CAPACITY Tons/Hour	REFERENCE
Coarse Coal:		
Dense Media Concentration	10 - 300	[18, pp. 9-25]
DMS Dense Media Washer	100 - 800	[18, pp. 9-27]
Driem Type Dense Media Vessel	250 - 900	[18, pp. 9-33]
Jigs	25 - 700	[18, pp. 9-62]
Fine Coal:		
Cyclone	50	[18, pp. 10-16]
Dry Concentration	up to 350	[18, pp. 11-4]
Hydrotator	up to 100	[6, pg. 44]
Deister Tables	10 - 15	[6, pg 442]
Froth Flotation	7 - 250	[5, pg 188]

TABLE VI-7

CAPACITIES OF DEWATERING SCREENS

TPH CAPACITY OF VIBRATING SCREENS DEWATERING FINE COAL AT 1-mm.

Screen Width (ft)	Maximum Water with Feed (gpm)	Size of Coal 1" x 0	1/2" x 0	3/8" x 0	5/16" x 0	1/4" x 0	3/16" x 0	1/8" x 0	10M x 0
3	550	49	45	40	37	31	30	25	20
4	770	68	63	56	52	45	42	35	28
5	990	88	81	72	67	58	54	45	36
6	1210	107	99	86	83	72	66	55	44
7	1430	127	117	104	97	85	78	65	52
8	1650	145	135	120	113	97	90	75	60

TPH CAPACITY OF VIBRATING SCREENS DEWATERING FINE COAL AT 1/2-mm.

Screen Width (ft)	Maximum Water with Feed (gpm)	Size of Coal 1" x 0	1/2" x 0	3/8" x 0	5/16" x 0	1/4" x 0	3/16" x 0	1/8" x 0	10M x 0
3	275	46	42	37	35	30	27	22	17
4	385	65	59	52	49	42	38	32	24
5	495	83	76	67	63	54	50	40	31
6	605	102	93	83	77	66	60	49	38
7	715	120	110	97	91	78	71	58	45
8	825	139	127	113	105	90	82	67	52

TPH CAPACITY OF VIBRATING SCREENS DEWATERING FINE COAL AT 1/4-mm.

Screen Width (ft)	Maximum Water with Feed (gpm)	Size of Coal 1" x 0	1/2" x 0	3/8" x 0	5/16" x 0	1/4" x 0	3/16" x 0	1/8" x 0	10M x 0
3	170	35	30	27	25	22	20	15	12
4	230	49	42	38	35	32	28	21	17
5	290	63	54	50	45	40	36	27	22
6	350	77	66	60	55	49	44	33	27
7	410	91	78	71	65	58	52	39	32
8	470	105	90	82	75	67	60	45	37

TPH CAPACITY OF VIBRATING SCREENS DEWATERING PRESIZED COAL AT 1/2-mm.

Screen Width (ft)	Maximum Water with Feed (gpm)	Size of Coal 5/16" x 3/32"	3/4" x 1/4"	1 1/4" x 1/4"	1 3/8" x 3/32"	2 1/4" x 1/4"	2 1/4" x 3/16"	3 1/2" x 1/4"	4" x 1/4"
3	350	45	50	55	60	65	70	75	80
4	490	63	70	77	84	91	98	105	112
5	630	81	90	99	108	117	126	135	148
6	770	99	110	121	132	143	154	165	180
7	910	117	130	143	156	170	182	195	215
8	1050	135	150	165	180	195	210	225	248

TABLE VI-7 CONTINUED

TPH CAPACITY OF VIBRATING SCREENS DEWATERING PRESIZED COAL AT ¼-IN.

Screen Width (ft)	Maximum Water with Feed (gpm)	Size of Coal						
		¾"x¼"	1¼"x¼"	2"x¼"	3"x¼"	4"x¼"	5"x½"	6"x½"
3	750	60	65	75	80	90	95	100
4	1050	84	91	105	112	126	133	140
5	1350	108	117	135	148	162	171	180
6	1650	132	143	165	180	198	209	220
7	1950	156	170	195	215	234	247	260
8	2250	180	195	225	248	270	285	300

TPH CAPACITY OF COMBINATION SIZING, DEWATERING AND DESLIMING SCREENS HANDLING ⅜-in BY 0 OR ¼-in. BY 0 COAL[c]

Size of Screen (ft)	Top Deck				Bottom Deck			
	Screen Cloth Opening, in.			Approx. Surface Moisture[b] (%)	Feed, in.			Approx. Surface Moisture[b] (%)
	0.10 x 2 11/16[a]	0.25 x 2 11/16	0.1875 x 3 1/10		0.10 x 0	⅛ x 0	3/16 x 0	
3 x 16	37	41	56	11–17	19	21	24	26–32
4 x 16	52	57	78	11–17	26	30	33	26–32
5 x 16	67	73	100	11–17	34	38	43	26–32
6 x 16	82	90	123	11–17	41	47	52	26–32
7 x 16	97	106	145	11–17	48	55	62	26–32
8 x 16	110	122	165	11–17	56	64	71	26–32

[a] Called 10 mesh by some operators.
[b] Surface moistures depend upon the analysis of the overproduct from the deck and the type of coal. Surface moisture will decrease as the top size of the overproduct is increased.
[c] Indicated capacity is only approximate. Use screen formula for wet screening to determine area required. Bed depth may be the limiting factor.

TPH CAPACITY OF SINGLE DECK HORIZONTAL MEDIA RECOVERY SCREENS AT ½-mm.

Size of Screen (ft)	Feed Size									
	⅜" x ½ mm	7/16" x 10 Mesh	¾" x ¼"	1" x ¼"	1¼" x ¼"	2" x ¼"	3" x ¼"	4" x ¼"	5" x ½"	6" x ½"
3 x 16	16	25	32	34	36	43	52	60	80	85
4 x 16	22	35	44	48	51	60	73	85	110	118
5 x 16	28	45	57	61	65	78	94	110	140	151
6 x 16	35	55	70	75	80	94	115	135	170	185
7 x 16	42	65	83	89	95	112	136	170	200	218
8 x 16	48	75	95	102	110	130	157	210	230	250

DEWATERING DISCHARGE RATE OF PARALLEL-ROD TYPE SCREEN SURFACES

Openings (mm.)	Gpm per Square Foot through Screen					
	Horizontal Vibrating Screen			Stationary Sieve—15° Slope		
	1/16" Top Rod	3/32" Top Rod	¼" Top Rod	1/10" Top Rod	3/32" Top Rod	⅛" Top Rod
¼	41	29	22	14	10	8
½	72	53	41	24	17	14
¾	97	73	58	32	24	19
1	117	90	72	39	30	24
1½	147	117	97	49	39	32
2	168	138	117	56	46	39
3	192	168	147	65	56	49

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VII. TRANSPORTATION: MINE TO RAILHEAD OR PREPARATION FACILITY

Unit train shipment is assumed from a central point which collects from mines within a 25-30 mile radius in order to obtain a total tonnage of 1-1.5 million tons of coal per year. This quantity is necessary to maintain a unit train rate of about 0.5-0.8 cents/ton-mile.

To qualify for participation in a cooperative, each mine should have an annual production of 100,000 to 500,000 tons/year. This calls for an hourly productivity of 33 to 167 tons/hour for two shifts of six hours each. Each coop could specify its own coal cleaning and/or prepration requirements; whether to require cleaned coal at the collecting point or to collect raw coal and charge cleaning expenses.

Based on currently available technology, there are several ways to ship from the mine to the collecting point. Because any new capital outlay must be justified within the productive life of the mine, it is preferred that the means of shipping be somewhat portable or is amortized prior to the depletion of the mine. Transport methods including pertinent costs are summarized in Table VII-1.

TABLE VII-1

AVAILABLE SYSTEMS FOR SHORT DISTANCE
TRANSPORT OF COAL AT LOW TONNAGE
(Less than 30 Miles)

Capacity: tons/year	100,000	500,000
tons/day	400	2,000
tons/hour (2 shifts of 6 hours each)	33.2	166.7
1. Unit train, 600 tons/shipment		
One train every (12 yellow-balled cars per train pulled by a 400 hp switcher to unload at unit train depot)	16 hrs	3 hrs
Cost assuming old rails are available and 5 mph	2¢/ton-mile	2¢/ton-mile
2. Trucks (Semis) 20 tons/load (Based on experience in 48 mile shipment from Murdock Mine to Vermillion Power Plant in Danville, Illinois - 4¢/ton-mile)		
Cost strongly dependent on terrain	5-10¢/ton-mile	5-10¢/ton-mile
3. Belt Conveyor, 30" wide (Based on 1962 Bureau of Mines study and information from Mountain States Engineers, Tucson, Arizona. Complete installed cost 2 miles: $5 million 25 miles: $40 million Equipment cost: $250/ft)	8¢/ton-mile	5¢/ton-mile
4. Pneumatic pipeline		
Low pressure, current practice, TABLE IV-2	3¢/ton-mile	
High pressure (to be tested)		1-2¢/ton-mile

A. Rails

Where railroad is already available between the mine and the collecting point, depending on the terrain and the state of maintenance of the rail, a minimum train of 600 tons may be made up of six yellow-balled cars of 100 tons of coal each or twelve such cars of 50 tons each. The weight will depend on the condition of the railroad. It is estimated that such a make-shift system would be viable even if a five mph speed limit has to be imposed. New rail will not be feasible for shipment of this type. Furthermore, the availability of yellow-balled cars depends on the existing number and age distribution of the current stock of hopper cars as well as company maintenance schedules. In brief, this system may be useful for some mines in some cooperatives and/or some cooperatives; it is unlikely to be available for cooperatives in general.

B. Trucks

Where a mine is not connected by rail to the collecting point and a road in tolerable shape is available, truck shipment represents a device of low initial but high operating cost. It is suitable for mines with an uncertain depletion time. Again dependent on terrain, the cost might be at the level of ten cents/ton-mile.

C. Belt Conveyor

Where rail or road is not available or round-about shipment over a long distance is caused by the terrain, belt conveyor might be justified, especially if the coal size is over three inches as mined and the owner does not acquire a crusher. The economics is such that belt conveyor is rarely justifiable for distances over a mile when compared to a pneumatic system. Further details are given in Appendix VII-A.

D. Pneumatic Pipeline

Based on current practice, the pneumatic pipeline appears most competitive with trucks and belt conveyors where rails are not available. Further details of Item 4 of Table VII-1 are summarized in Table VII-2, showing the design variables. Pressure feed is limited to 20 psig. such that high pressure feed bins and switching are not needed while the vacuum suction is limited to -10 psi. vacuum as an economical limit. Table VII-3 shows various push-pull options. Table VII-2 shows distances up to three miles, but a longer distance line can be designed. One way to cover a distance of 24 miles, for instance, is to repeat using six modules of four miles each. Since the gravity effect is not a big factor in the pressure drop in a pneumatic system, the latter can cover the steepest terrain using the most direct route. Since very little ground preparation is

needed for installing a pneumatic system; it is almost portable if relocation is needed. Because this system is more recent than the others, its details and requirements are further delineated in Appendix VII-B.

TABLE VII-2

DESIGN PARAMETERS -- PNEUMATIC PIPELINES
FOR SHORT DISTANCES
(2x0" Coal, unpressurized coal feed)

Capacity: tons/year	100,000	500,000
tons/hour	20	100
Pipe diameter, inches	10	18
Air flow, scfm	2,500	12,000
1000 foot transfer		
Pressure drop, psi	2.8	1.4
Inlet pressure	atmospheric	atmospheric
Discharge suction, psi vac.	-2.8	-1.4
Blower hp. at discharge	50	125
Installed cost	$200,000	$600,000
1 mile transfer		
Pressure drop, psi	14.7	7.3
Inlet pressure, psig	15*	atmospheric
Blower hp. at inlet	250	--
Discharge suction, psi vac.	atmospheric	-7.3
Blower hp. at discharge	0	650
hp./(ton/hr)	12.5	6.5
Installed cost	$216,000	$648,000
1.5 mile transfer		
Pressure drop, psi	22	
Inlet pressure, psig	15*	
Blower hp. at inlet	250	
Discharge suction, psi vac.	-7	
Blower hp. at discharge	125	
Installed cost	$226,000	
2 mile transfer		
Pressure drop, psi		14.7
Inlet pressure, psig		15*
Blower hp. at inlet		1,250
Discharge suction, psi vac.		atmospheric
Installed cost		$696,000
3 mile transfer		
Pressure drop, psi		22
Inlet pressure, psig		15*
Blower hp. at inlet		1,250
Discharge suction, psi vac.		-7
Blower hp. at discharge		600
Installed cost		$744,000

NOTES TO TABLE VI-2:

* With rotary feeder (A.S.H. Fluid Transport Division, Envirotech Corporation, King of Prussia, Pennsylvania, 19406).

a. Each of the above pipelines may handle five times more coal than indicated at doubled hp if high pressure feed bins are used.

b. The above pipelines are specified based on current practice of Radmark Engineering Division, Rader Pneumatics Limited, Box 20128, Portland, Oregon, 97220.

TABLE VII-3

DESIGN OPTIONS -- PNEUMATIC PIPELINE SYSTEM

Vacuum Systems

An air flow is created through a vacuum producer located on the side of the material collector opposite to the conveying pipeline. Vacuum producers may be mechanical, steam jet or water jet.

These systems are especially effective and economical in picking up material from many points and delivering to one remotely located process or storage area.

Pressure Systems

Materials are moved in an air flow created by a positive displacement blower located in front of the material inlet. This is an economical, compact system for picking up product from one area and delivering to many points. Extremely flexible, the system can be applied for unloading, in-plant transferring, and recirculating materials over greater distances than with vacuum systems.

Vacuum-Pressure Systems

These systems are employed for moving materials in air flows created by the application of both vacuum and pressure principles. They are most economical in applications requiring the collection of materials at a number of points for delivery to several destinations, and for conveying over great distances.

APPENDIX VII-A

CONVEYOR BELT SYSTEM

Considerable engineering and design data have been developed by companies such as the Riverlake Belt Conveyor Lines, Inc., and Mountain State Express, through joint efforts by several conveyor and equipment manufacturers to design and install long-distance conveyors. Most of the belts were supplied by the Goodyear Tire and Rubber Company. Many engineering factors must be considered and the various engineering components involved are briefly described as follows: [8,10]*

A. Structural Work

1. Conveyors. The main line conveyors and customer laterals should be contained in a common enclosure between all transfer stations. This enclosure is visualized as a semicircular structure up to approximately 18 feet in diameter with ribs being spaced on 4-foot centers and covered by galvanized 26-gauge corrugated sheets. Gravity ventilation is provided for these enclosures where necessary. Industrial steel doors of the panic type spaced about 300 feet apart along the side of the housing are required. The conveyor system is for the most part located at ground level, supported on a concrete slab laid on granulated material laid over a properly drained subgrade. Where it is necessary to elevate the conveyors over roads, railroads, valleys, rivers, and other obstacles, the

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*Numbers in brackets refer to references at the end of section.

elevated sections would be supported on structural steel trusses. All transfer stations would be connected to the nearest public thoroughfare by stabilized gravel roads.

2. Fire Protection and Water Supply. Service water for fire protection and dust control would be provided through a water main (up to 8" diameter) which would parallel approximately 90 percent of the main conveyor length. This main would be served from existing water supply systems through booster pumps, provided supplies could be found within a mile or so of the pumping stations. The water supply for the remaining 10 percent of the conveyor route would be obtained from existing facilities.

A complete rate-of-rise fire protection system would be constructed at each transfer house, consisting of sprinkler heads and piping supplied from the service main through a deluge valve operated by heat-actuated devices. Fire protection for the belt between transfer houses is not considered necessary except that that sprinkler system would extend along the conveyor structure for 100 feet in each direction from each transfer house.

3. Dust Control. Means for dust control at all transfer points in the main line include dust arrester and evaporation makeup systems provided by water sprays, consisting of piping from the service main and nozzles with manual control.

B. Mechanical Equipment

Coal handling equipment at the mine site includes loading facilities, storage facilities, and emergency shortcut stockpiling facilities with the necessary stackers. The conveyor equipment provided at the shortcut storage bins would permit transferring coal from the mine mouth to the conveyor system at various rates. Unloading facilities are provided at the discharge end of the conveyor. The mechanical equipment along the main conveyor line would be similar to that now in service in the mining industry with the addition of weightometers as necessary to control the routing of the coal. Monorail service hoists for each junction house would be provided to handle the servicing of heavy equipment. Various machine shops, portable maintenance equipment, trucks, and and tools required for shops along with some type of patrol cars for main line inspection would have to be provided.

C. Electrical Work

The motors are standard drip-proof type with primary and secondary controls with a sufficient number of secondary steps to satisfy the starting and acceleration requirements of the belt. Acceleration times can be chosen so that the maximum starting torque will not apply more than 150 percent of the motor running torque. Normal overloading protection would be provided to take the motor out of service due to excessive heating or overload.

At all junction houses, 480-volt secondary transformers would have to be provided, along with a load center consisting

of one or more main air circuit breakers, depending upon the number of drive motors at each junction point. The necessary interlocking system is needed to provide for a sequential startup and shut-down of the belt during normal or emergency operation.

APPENDIX VII-B

PNEUMATIC PIPELINE

Numerous systems were installed for pneumatic conveying and stowing of lump-size materials. For example, coals of 3/4-inch top size have been successfully conveyed pneumatically through 470 feet of 12-inch pipe at 30 tph for several years in one U.S. installation [3]. In Germany, washery refuse up to 3 inches in size has been conveyed pneumatically at rates above 200 tph through 8-inch pipe for distances exceeding 1,000 feet [2]. Also in Germany, up to 1-inch coal has been lifted pneumatically through a vertical distance of 1,080 feet through a 7-1/2-pipe at 55 tph [1], and a pneumatic installation for feeding boilers is known to convey coal up to 1-3/4 inch through 6-inch pipe at 15 tph over distances of 150 feet [5]. In Great Britain, 1-inch coal was conveyed experimentally through 5-inch diameter 45-foot long vertical pipe and then through a 70-foot long horizontal section [4]. In the U.S.S.R., pneumatic transport reportedly is used in some mines to extract intermediate layers (inclusions) of coal [6].

Pneumatic Coal Transport System [7,11]

A technical and economic evaluation of pneumatic coal pipelining has been made in an experimental installation as shown in Figure 1. Test parameters include the coal rates and sizes

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*Numbers in brackets refer to references at the end of section.

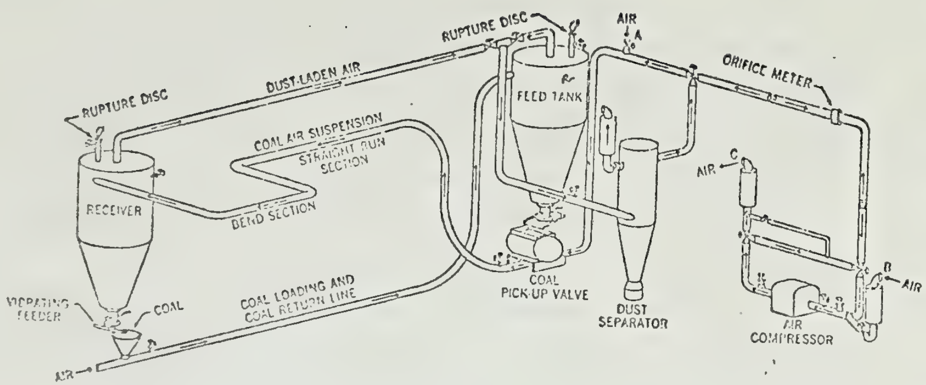

Figure 1. Sketch of Experimental Pneumatic Coal Transport Plant Showing Typical Components.

that can be efficiently conveyed pneumatically, pipe sizes, air volume and compression power requirements, and pipe erosion. Technical feasibility depends mostly on whether a pneumatic system can be successfully operated and whether it can meet or exceed the haulage capabilities of existing systems. Economic feasibility depends largely on the capital and operating costs of air compression equipment. Haulage capabilities and air requirements thus appear to be the major factors needing study. These, in turn vary in accordance with characteristics of the pneumatic system (horizontal or vertical, vacuum or pressure), the diameter, length, and configuration of the pipe, and the size, size distribution, moisture content, and ash (slate and shale) content of the coal. Data are desired for as wide as possible range of coal characteristics, pipe specifications, and pneumatic techniques. Also desirable is information on the erosion of pipe and bends, coal degradation, and mechanical techniques.

Figure 1 is a sketch of the experimental pneumatic coal-transport pilot plant which incorporates components which might be used in actual installations, although not simultaneously. Four pipelines of different diameters consisting of straight horizontal runs and bends lead from a 7-ton feed tank to a receiver. The four pipelines are 2-, 4-, 6-, and 8 inches in diameter and are made of mild steel. Straight runs of 200 feet in length are followed by shorter runs containing 8-, 6-, and 4-foot radii bends in succession.

The 2,500-cfm compressor in the system permits operation at vacuum to 20 inches mercury and pressures to 20 psig. During vacuum operation, air enters the system at point A, picks up coal at the rotary value (Figure 2), and the coal-air suspension is pulled through the test piping and the coal is depositied in the receiver. Dusty air from the receiver is pulled into the dust-separator for cleanup, and the clean air proceeds through the compressor and is discharged into the atmosphere.

When the system is operated under pressure, air enters at point B, is pulled through the compressor, pressurized, and piped to the coal pick-up valve. The coal-air suspension is pushed through the test piping and the coal is depositied in the receiver. Again, dust-laden air from the receiver is forced into the dust-separator for cleanup followed by exhaust to the atmosphere.

Mine run coals of varying moisture and ash contents and crushed to various sizes up to 2 inches are to be fed from the feed vessel into the 100-tph rotary valve feeder. Feed rate is controlled by a variable-speed vibratory-pan feeder that drops the coal by free-fall into the rotary-valve feeder. With this method of feeding, the rotary-valve feeder (Figure 2), which will handle only small particles under normal choke-feeding conditions, can satisfactorily feed the larger 2-inch coal sizes.

Feed

The practices established in the design and operation of the pneumatic mine hoist [9] might be applied directly to the transport system.

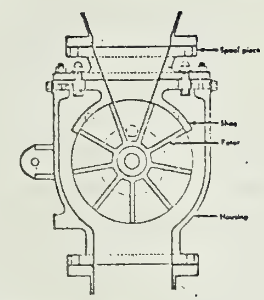

Figure 2. Rotary-Valve Feeder.

At the mine, material was transferred from the concentrator pile by means of a front-end loader and the inlet to a RTL 200 Feeder was controlled by a Syntron vibrator unit, and the complete system was operated by one man on the control console. An output of up to 40 tph was achieved. Systems of 200 tph are commonplace. Materials with pieces as large as 3 inches can be handled. An alternate means is to have the mine cars unloaded onto a conveyor to the feeder.

For handling coal as mined, the vibrator feed, which includes large lumps, can be diverted from a grate which allows passage of 2x0" coal, to a 10x15 jaw crusher set at 2" to 3". A manual deflector at the discharge of the crusher into the inlet joins the coal from the vibrator grate with that diverted to the preparation unit.

Safety Features

When the system is operating, the possibility of explosion in the pipelines is remote because the high transport velocities make it difficult or impossible for flames to propagate. In the vessels and separator, and during startup and shut-down, velocities are lower and a remote possibility of explosion exists. As a safety precaution, inert gas is piped to various points of the system for purging to prevent fire and explosions during startup and shut-down with sufficient inert gas being introduced to keep the O_2 concentration below 15 volume-percent.

The system can be designed to contain an explosion, according to approved practices in the installation and operation of pulverized fuel systems. Such practices require equipment to withstand explosion pressures up to 50 psig when pneumatically conveying powdered coal at absolute pressures up to one atmosphere. Equipment rated proportionately higher is needed for higher operating pressures. Vacuum operations require that all the main vessels be capable of containing explosive pressures up to 50 psig. The separator and the receiver are operated under low pressure, not exceeding 3 psig, which requires that they be designed to contain an explosive pressure of 60 psig. A 3-psig rupture disc limits the pressure in the receiver. This limited operating pressure can be maintained even with a 20-psig pressure at the coal pick-up point, since nearly all of this 20 pounds is used to transport the coal through the experimental pipeline. Both vessels are designed for 150-psig working pressures and have been previously operated at pressures up to 60 psig; the separator has been pressure tested satisfactorily to 60 psig.

APPENDIX VII-C

TRUCK TRANSPORTATION

Some of the problems and costs inherent in truck transportation are exemplified by the situation in Kentucky.

There are two basic methods of transporting coal from the eastern Kentucky coal region: by truck and by rail. In 1973, about 32 percent of the region's coal was shipped by rail and almost 68 percent of the coal from eastern Kentucky moved by truck. In 1956, 60 percent of eastern Kentucky coal was transported by rail. The shift is due to the fact that the utilization of rail lines is self-limiting because of their location. Rail lines cannot move and accommodate shifts in areas of production. Second, there has been a significant deterioration in railroad physical plant and railroad services including the shortage of available hopper cars in recent years. Third, there is a significant improvement in the efficiency and local carrying capacity of motor vehicles used for coal hauling purposes.

This shift to trucks has been accompanied by increases in the number of trucks used for coal hauling purposes, increases in the frequency of coal-haul trips per truck (previous eight hour coal-haul shifts have regularly been increased to twelve, sixteen and even twenty-four hour shifts) and, finally, increases in the average coal load per truck per trip have occurred. One of the results of this has been a substantial destruction and deterioration of much of eastern Kentucky's highway network being subjected to coal hauling.

In western Kentucky, trucks handle approximately 25 percent of the coal haulage, up about 10 percent in 1960, but stabilized since 1970. The stabilization has occurred in large part as a result of increased usage of river barges and conveyor belts as modes of transportation.

Where trucks have been used there has been some deterioration in highway quality and capacity as a result of coal hauling. It is expected that a substantial increase in the number of heavily laden trucks will have a serious, if not disastrous effect upon the highways over which those trucks must travel.

It is reported that high construction costs, particularly in a mountain area, together with limited funds, have resulted in a highly deficient highway system in the eastern Kentucky region. More miles of highway become inadequate annually than can be improved. Coal haul demands on all roads have resulted in marginally deficient roads becoming highly inadequate. Approximately 75 percent of all state maintained roads upon which coal is hauled are deficient. In the eastern Kentucky region, approximately 85 percent of all such state maintained roads are inadequate. Normal deterioration, accelerated by the impact of heavy coal hauling has created an impossible maintenance problem. Coal trucks with gross weights in excess of 90,000 pounds traveling on roads designed for load limits of from 30,000 to 70,000 pounds, cause intermediate-type bitumi-

nous roads to fail and become rutted. The final result is a road which serves neither the local resident nor the trucker.

Table VII-C-1 gives an indication of some of the construction and maintenance costs associated with heavy coal haulage in the Kentucky region. Of particular interest to the cooperatives is the annual maintenance after restoration. The Kentucky report indicates that local roads are structurally highly inadequate to support the coal haulage requirements placed upon them. Prior to trucking demands, they provided a minimal usable facility for the rural resident. The roads are now highly inadequate as a whole.

TABLE VII-C-1

AVERAGE PER MILE COSTS FOR KENTUCKY COAL HAUL ROADS - STATE HIGHWAY SYSTEM ($1,000)

	Restoration	Annual Maintenance After Restoration	Cost of Improvement for Heavy Cost Haul	Cost of Reconstruction to Traffic Bound Macadam	Cost of Approved Design Standard for Heavy Coal Haul
Eastern Kentucky Region:					
Total	16.9	8.9	121.3	24.7	596.1
State Secondary System	19.3	10.1	162.7	---	832.7
Rural Secondary System	19.9	11.9	169.1	---	564.0
Western Kentucky Region:					
Total	5.8	2.3	56.0	1.3	209.1
State Secondary System	8.0	2.1	82.1	---	270.1
Rural Secondary System	16.2	2.3	105.8	---	359.8

SOURCE: Kentucky Department of Transportation, Kentucky Coal and Its Transportation Impacts, Table V, p. 50.

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VIII. TRANSPORTATION - UNIT TRAINS

A. Loading Facilities for Unit Trains

Viability of a unit train operation depends upon: a regular buyer of sufficient size, a coal supplier or suppliers with sufficient productive capacity, and rail transportation between source and use points. Rapid loading devices at the starting point help reduce the total cost. For a 10,000-ton train, a minimum of $900,000 (adjusted to current prices) might be invested in a rapid loading facility.[1]

A smaller tonnage than one million tons/year does not justify the capital expenditures to furnish facilities for loading. Loading a 10,000-ton unit train must be performed in two to four hours; the low cost transportation of coal depends on adequate facilities for rapid loading and unloading.

Coal handling at the loading point requires the provision of a surge pile or bin between normal rates of production and the rapid rates of flow essential to the unit train. The objective is to get the coal into the cars with dispatch. At the loading point, recovery at high rates from the surge pile is required; at the destination, the rate can be accommodated to the time and labor available.

A conical pile having a radius of 100 feet and sides sloping at 35° to 37° will have a height of 70 feet. Assuming 40 cubic feet to the ton, such a pile will have a capacity of

about 15,000 tons. If the coal is to be recovered from the center through a 3'-0" square hole located at ground line, about 3,000 tons or 20 percent will be live storage. This is based on a 45° angle of repose of the internal cone. For many coals, especially those high in fines and moisture, recovery will be far less and in some cases "rat-holing" will result.

Assuming that the coal is delivered to the top of a 15,000 ton pile and that the base of the pile has been properly prepared, the economics of a 15,000 ton pile (all prices are in 1964 dollars) are:

(a) With a conveyor in a tunnel, at the ground line of the pile and originating at the center, with a single feeder;
3,000 live tons would be recovered leaving 12,000 tons in "dead" storage,

(1) At $4 per ton, the "bin" would be valued at $48,000.

(2) At $7 per ton, the "bin" would be valued at $84,000.

(b) Extending the conveyor the full diameter, one plant added the extra 100' to its conveyor, including a 6' x 6' concrete tunnel with 12" walls at a cost of,

Excavation - 240 yards at $1.00	$ 240
Concrete - 110 yards at $80.00	8,800
Gates -	2,400
Additional conveyor - 100' at $80.00	
(36" belt - 60 tph at 500 fpm)	
including added Hp -	8,560
Total	$20,000

The recovery then became 50 percent "live" storage and only 7,500 tons remained with a value of $30,000 or $52,000 respectively as the "bin." Recovery rate was also increased because of additional openings.

In case (a), recovery of the remaining coal, 12,000 tons, with dozers having a 10-ton coal-blade and a hopper over the belt to hold this amount required 12,000 t/400 tph = 30 machine-hours. The dozers have to start to work near the top of the remaining coal in recovering the pile.

In case (b), the dozers were at the base quickly, and therefore, 7,500 t/600 tph = 12.5 machine-hours were sufficient for total recovery.

Stacking conveyors feeding the conical pile range in cost from $100 to more than $200 per running foot, depending on belt size and type of structure.

The support at the head of the conveyor will normally be a 4' to 6' steel pipe acting also as a lowering well. A cantilevered construction from a tower structure may be used. The

latter permits freer movement of the recovery unit when "pushing" into a center feed hopper. Care must be used to prevent coal compaction over feed hoppers when "pushing."

Multiple in-line conical piles from a single feed source normally require a short auxiliary conveyor that may run in one direction for two piles or, if for three piles, be reversible so that piles can be added on each side of the feed belt terminal. Multiple conical piles are wasteful of space and should be avoided unless different product sizes or quality are required or result from different coals being produced from several mines. The recovery is also complicated.

In some areas recovery from conical, windrow, kidney-shaped, spread or other type piles can be very economically done by dozers with blades of up to 30 tons and more, by scraper loaders to 60 tons and larger, by hi-lifts of 40 yards plus (2 buckets equal a railroad car), by a wheel-type excavator in a range of 1,000 to 4,000 tons per hours, and by several rake type units working on one face of the pile. These units are spread through a price range of from $60,000 to $450,000.

Windrow storage is usually accomplished by use of: (a) traveling stacker; (b) fixed stacker with long tripper belt; (c) wheel; and (d) combination of tripper belt and slingers.

Figure I shows a layout of windrow piles and a method for stacking and reclaiming. Note that in the first stage all is recovered while in the second stage 60,000 tons or 23 percent must be moved to within reach of the wheel by dozer.

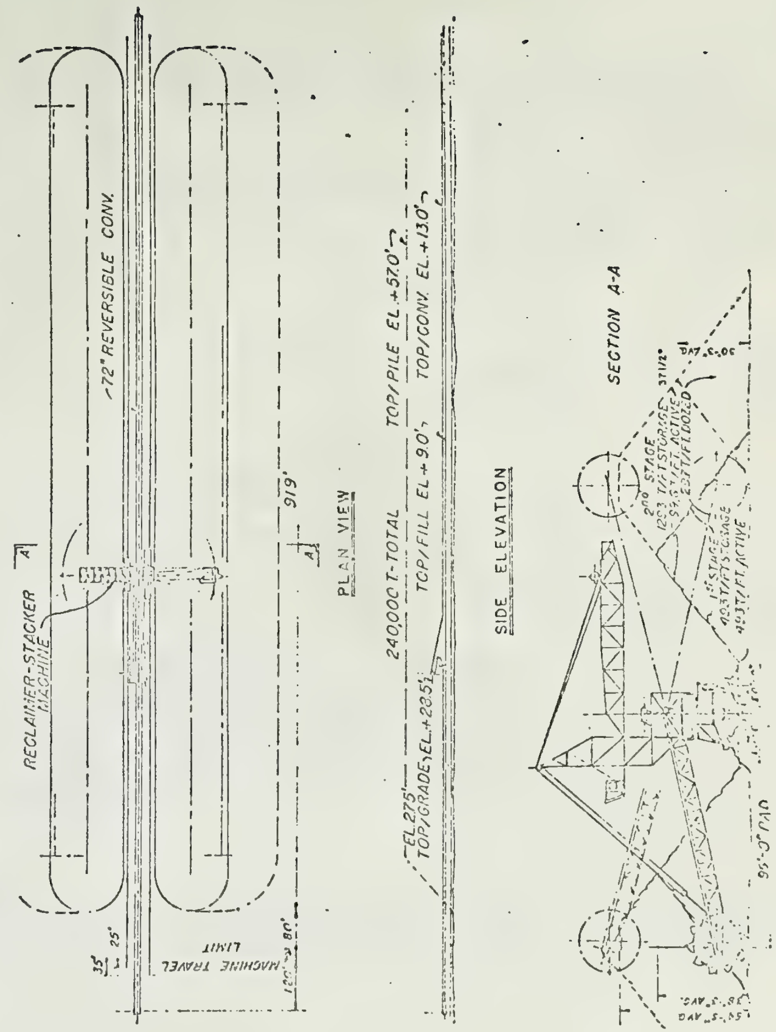

Figure 1. Twin windrow storage with wheel machine used for stocking and reclaiming.

Kidney-shaped piles are usually laid down by pivoted and hinged belt booms that can be rotated through an arc as well as raised and lowered. Such a conveyor is normally fed at its pivot point. The cost of this type of cantilevered boom, some exceeding 250 feet in length, varies, depending on belt size and boom length, from $250 to more than $600 per foot.

In the spread type pile of 100,000 to 500,000 tons attaining 40 or more feet in height, compaction is a must, thereby eliminating free gravity flow to hoppers. Normally trucks and dozers, or scraper loaders are used because they provide transport as well as compaction. At the Paradise TVA plant three 60-ton three-wheeled scraper loaders were used to build and compact some 600,000 tons of coal in a 40-foot high spread pile. These units cost about $125,000 each and handle 2,000 tons per hour when recovering into a 50-foot square hopper having a hopper capacity of 230 tons.

Another method of storage is in bins or silos. Studies have shown that at 1,500-2,000 tons capacity per unit, silos of concrete construction may be cheaper than steel bins. Figure 2 shows an arrangement for loading and unloading a nest of five silos having a capacity of 10,000 tons. The loading rate is 2,500 tons per hour into railroad cars. Several methods are available for distributing coal to silos. In the case shown, coal is chuted to either of the distributing conveyors.

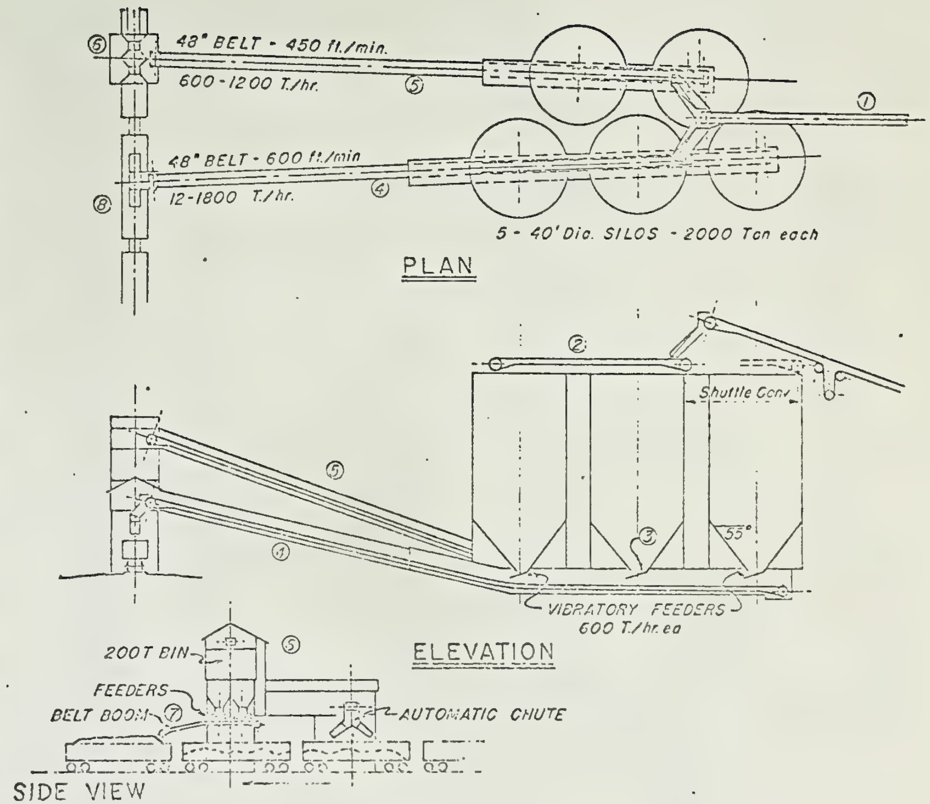

Figure 2. Train loading station with silo storage. A word of caution, ventilate silos used for freshly mined coal to prevent gas and dust accumulation.

Draw-off from the silos is made more reliable when the bottom slope sheets are at an angle of about 60°.

To reduce the size of equipment and simplify control, loading is undertaken at two points. The cars are rough-loaded by belt (4) and an automatic chute (8) provided to prevent spillage between cars. If train speed varies, the operator adjusts the loading rate of the belt boom (7).

Without abnormal foundations the installation shown requires an investment of about $800,000, including automatic loading chute and signals.

In order to properly feed a conveyor used in recovery of coal, control of the feed is important. Undercut, overcut, or rack and pinion operated flat gates provide control. Both flat and swinging gates can be remotely controlled.

Feeders of many types are available. Thse include reciprocating pan feeders, (mechanical or hydraulic), horizontal narrow flight or pan conveyors, vibrating magnetic and motor driven vibrating feeders. These feeders act as gates when their length is such that their discharge point extends beyond the angle of repose of the material. Automatic regulation of the rate of feed can be added to all.

A typical unit train loading terminal with a 15,000-ton pile, a feed of 1,000 tons/hour to the pile and recovery rate of 5,000 tons/hour is shown in Figure 3. The total ground area required, approximates 550 feet in length and 200 feet in width. This general arrangement shows the stacking conveyor, feeders,

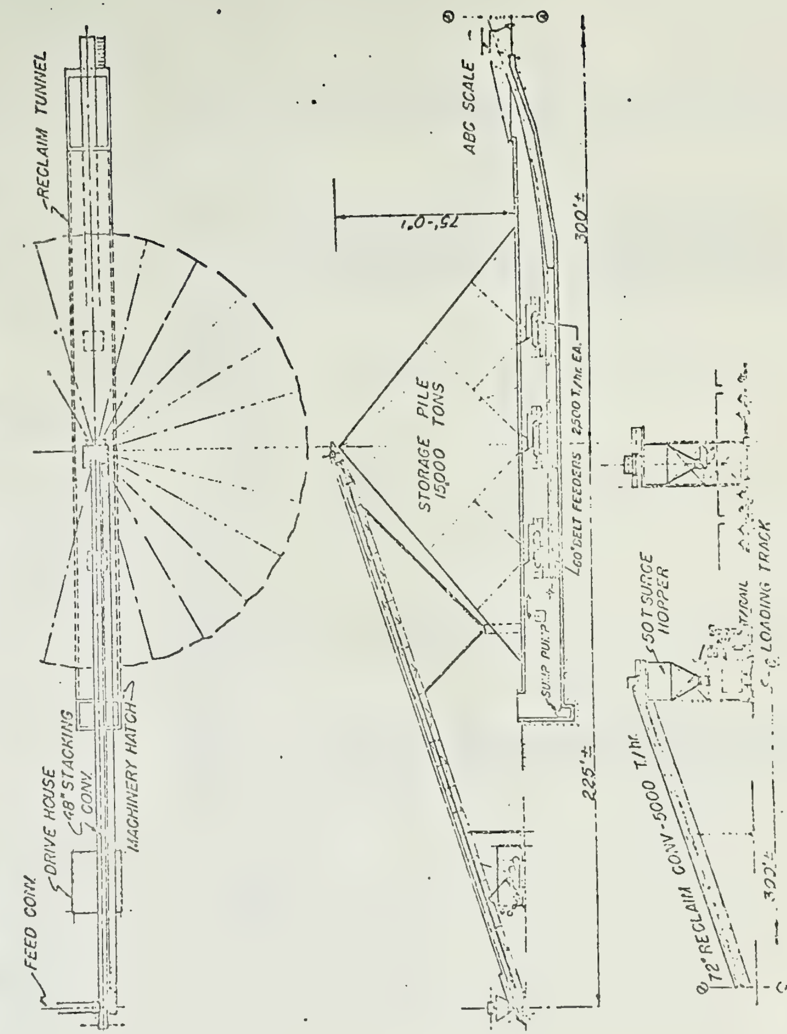

Figure 3. Storage or Surge Pile, shown for train loading. A terminal recovery belt and feeders may be sized smaller.

recovery belt and loading facilities. Three men are required for the operation: Loading Operator, Tunnel Man (Mechanic) and Tractor Dozer Operator. The approximate cost of such an installation in normal ground is $450,000.

Loading into the railroad cars at rates up to 2,500 tons/hour is currently being done. Bifurcated chutes with a flop gate is still the simplest and best type of gate for loading up to 2,500 tons/hour. At rates higher than this, train speed becomes a serious factor as it is almost impossible to load cars uniformly without positive regulation of train movement.

Belt scales provide a means of weighing the coal as it is being loaded.

To consider the capital requirements on the basis of a producer-consumer pair, assume 7,000-ton trains on alternate days, which have an annual capability of 1,050,000 tons. Storage and loading improvements at the mine will have required about $450,000 which, with a ten-year amortization and other costs, will amount to less than $65,000 per year. To carry coal from this mine, 74 special 100-ton cars will cost $980,000 or about $140,000 per year with a 10-year amortization.

B. Unit Train Rates

An analysis of unit train rates was made based on reference [2] from which a part of Table A-3 has been reproduced and rearranged into Table VIII-1. The following conclusions can be drawn: (1) cost per ton-mile increases with decreasing distance but the

TABLE VIII-1

UNIT TRAIN STATISTICS

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Western Pennsylvania-						
-Connecticut	502	7	-	1	13,336	.87
	645	7	-	1	13,336	.91
	604	7	-	1	13,336	.86
	608	7	-	1	13,336	.73
	645	-	-	1	13,336	.68
-Massachusetts	502	7	-	1	13,336	.87
	659	7	-	1	13,336	.93
	701	7	-	1	13,336	.89
	482	7	-	1	13,336	.89
	656	7	-	1	13,336	.93
-New Hampshire	754	7	-	1	13,336	.85
	870	9	900	1	13,336	.85
-New Jersey	480	7	-	1	13,336	1.04
	401	7	-	1	13,336	1.21
	428	7	-	1	13,336	1.13
	419	7	-	1	13,336	1.04
	482	7	-	1	13,336	.96
	442	7	-	1	13,336	1.10
	541	7	-	1	13,336	.95
-New York	651	7	-	1	13,336	.81
	482	7	-	1	13,336	.96
	500	7	-	1	13,336	1.02
	528	7	-	1	13,336	1.00
	659	7	-	1	13,336	.86
	538	7	-	1	13,336	.98
	567	7	-	1	13,336	.99
	613	7	-	1	13,336	.97

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* 1=Railroad owned.
2=Shipper owned.

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Western Pennsylvania-						
-New York (cont.)	607	7	-	1	13,336	.87
	608	7	-	1	13,336	.77
	391	7	-	1	13,336	1.24
	446	7	-	1	13,336	1.09
	543	7	-	1	13,336	.97
	300	7	-	1	13,336	1.37
	393	7	-	1	13,336	1.09
	178	6	-	1	13,336	1.74
	147	7	-	1	13,336	2.37
	229	7	-	1	13,336	1.62
	335	7	-	1	13,336	1.21
	477	7	500	1	13,336	.92
	505	7	-	1	13,336	.99
	676	7	-	1	13,336	.78
	376	7	-	1	13,336	1.14
	434	7	-	1	13,336	1.03
	426	7	-	1	13,336	1.14
	594	7	-	1	13,336	.89
	502	7	-	1	13,336	.86
	659	7	-	1	13,336	.86
	376	7	-	1	13,336	1.06
	434	7	-	1	13,336	1.04
	528	7	-	1	13,336	1.00
-Rhode Island	482	7	-	1	13,336	.89
-Vermont	682	7	-	1	13,336	.98

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Northern West Virginia-						
-Connecticut	613	7	-	1	13,496	.74
	756	7	-	1	13,496	.83
	715	7	-	1	13,496	.75
-Massachusetts	613	7	-	1	13,496	.74
	770	7	-	1	13,496	.87
	812	7	-	1	13,496	.79
	593	7	-	1	13,496	.76
	767	7	-	1	13,496	.82
	767	7	-	1	13,496	1.06
-New Jersey	591	7	-	1	13,496	.87
	595	7	-	1	13,496	.87
	539	7	-	1	13,496	.93
	530	7	-	1	13,496	.86
	593	7	-	1	13,496	.81
	652	7	-	1	13,496	.81
	300	2	25	1	13,496	3.00
-New York	688	7	-	1	13,496	.79
	762	7	-	1	13,496	.72
	593	7	-	1	13,496	.81
	611	7	-	1	13,496	.87
	639	7	-	1	13,496	.85
	770	7	-	1	13,496	.76
	649	7	-	1	13,496	.84
	678	7	-	1	13,496	.86
	724	7	-	1	13,496	.85
	719	7	-	1	13,496	.76
	719	7	-	1	13,496	.68
	502	7	-	1	13,496	1.00

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Northern West Virginia-						
-New York (cont.)	557	7	-	1	13,496	.90
	654	7	-	1	13,496	.83
	748	7	-	1	13,496	.69
	787	7	-	1	13,496	.69
	537	7	-	1	13,496	.94
	705	7	-	1	13,496	.77
	613	7	-	1	13,496	.73
	600	-	-	1	13,496	.83
	253	-	-	1	13,496	1.73
	654	7	-	1	13,496	.83
	770	7	-	1	13,496	.76
	649	7	-	1	13,496	.84
-Rhode Island	593	7	-	1	13,496	.76
-Vermont	793	7	-	1	13,496	.91
Ohio-						
-Ohio	93	10	2,500	1	12,234	2.02
	138	10	2,500	1	12,234	1.49
	143	8	-	2	12,234	1.50
	165	8	-	2	12,234	1.58
	101	8	-	2	12,234	2.05
	145	8	-	2	12,234	1.68
	159	8	-	2	12,234	1.53
	134	8	-	2	12,234	1.82
	158	8	-	2	12,234	1.54
	120	8	-	2	12,234	2.03
	156	8	-	2	12,234	1.56

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Ohio-						
-Ohio	22	3	600	1	12,234	4,45
	35	3	-	1	12,234	2.80
	43	3	-	1	12,234	2.28
	36	3	-	1	12,234	2.72
	24	3	-	1	12,234	4.08
	196	10	720	1	12,234	1.34
	330	10	480	1	12,234	1.26
	240	-	-	1	12,234	1.68
	270	10	720	1	12,234	.97
	60	1	600	1	12,234	1.38
	16	-	-	2	12,234	.75
	60	-	-	1	12,234	1.93
	155	10	2,500	1	12,234	1.21
	143	8	-	2	12,234	1.50
	250	-	850	1	12,234	1.90
	125	-	-	1	12,234	2.82
	262	-	-	1	12,234	1.81
	133	7	-	1	12,234	2.52
	67	5	-	1	12,234	1.72
	186	7	-	1	12,234	2.27
	188	10	720	1	12,234	1.38
	201	6	800	1	12,234	1.67
	90	-	200	1	12,234	4.26
	376	10	480	1	12,234	1.10
	150	10	-	1	12,234	2.72
Panhandle-						
-Ohio	56	-	-	1	12,762	.64

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Southern #1-						
-New Jersey	547	7	-	1	14,040	1.12
	617	7	-	1	14,040	.99
	549	7	-	1	14,040	1.11
	619	7	-	1	14.040	.99
	505	7	-	1	14,040	1.19
	575	7	-	1	14,040	1.04
	519	7	-	1	14,040	1.15
	589	7	-	1	14,040	1.02
	628	7	-	1	14,040	.96
	604	7	-	1	14,040	1.04
	440	7	-	1	14,040	1.31
	582	7	-	1	14,040	1.01
	582	7	-	1	14,040	1.06
	378	7	-	1	14,040	1.50
-New York	604	7	-	1	14,040	1.04
Southern #2-						
-New Jersey	448	7	-	1	13,663	1.34
	520	7	-	1	13,663	1.09
-New York	700	-	-	1	13,663	.90
	532	10	-	1	13,663	.98
-Ohio	395	10	480	1	13,663	1.05
	408	-	-	1	13,663	1.25
	325	-	-	1	13,663	1.46
	360	7	480	1	13,663	1.09

TABLE VIII-1 Continued

ORIGIN-DESTINATION	SHIPPING DISTANCE (miles)	MINIMUM TONNAGE TRAINLOAD (thousands)	ANNUAL TONNAGE (thousands)	TRANSPORTATION EQUIPMENT OWNER*	AVERAGE BTU/POUND	COST (¢/ton-mile)
Illinois-						
-Illinois	42	-	1,260	1	11,400	2.64
	44	-	1,260	1	11,400	2.36
	60	-	300	1	11,400	1.71
	300	10	1,000	1	11,400	.40
	238	5	1,000	1	11,400	.69
	75	4	1,300	1	11,400	1.87
	310	5	-	1	11,400	1.43
	236	9	900	1	11,400	.82
	341	10	1,600	2	11,400	.68
	150	10	-	2	11,400	1.91
	264	5	-	1	11,400	1.23
	85	5	1,000	1	11,400	.86
	61	5	1,000	1	11,400	1.72
	61	5	1,300	1	11,400	1.66
	308	7	3,300	1	11,400	.55
	84	10	-	1	11,400	1.66
-Indiana	215	10	1,500	1	11,400	1.31
	215	10	1,500	1	11,400	1.37
	215	10	1,500	1	11,400	1.15
-Iowa	35	-	-	1	11,400	7.60
	35	-	100	1	11,400	6.57
	35	-	-	1	11,400	7.30
	83	2	400	1	11,400	1.30
	83	2	500	1	11,400	1.28
	83	2	600	1	11,400	1.25
	59	3	300	1	11,400	2.78

relationship is not uniform. The conclusion is supported by the evidence of shipments from Western Pennsylvania to New York and New Jersey; Northern West Virginia to New York and New Jersey; and Southern #1 to New Jersey. However, rates from Western Pennsylvania and Northern West Viginia to Connecticut and Massachusetts are perverse. (2) There is no close relationship between rates and average annual tonnage shipped (intrastate Ohio and Illinois). Given distance, the rates show some tendency to increase with decreasing average annual tonnage but the relation is weak and there are numerous exceptions. However, very small shipments, below 200-250 thousand tons/year appear to pay a penalty. (3) Ownership of the unit train does not appear to be a significant factor. (4) Train weight does not appear to be a significant factor.

For comparison with the rates published by the Bureau of Mines, Table VIII-2 provides nine current tariffs obtained from Illinois Central-Gulf. Additionally, two tariffs obtained from the Canadian National Railways have been provided. It may be noted that these are significantly lower than U.S. rates. It is reported that the Canadian National rates are competitive with the Canadian Pacific rates.

TABLE VIII-2

NINE CURRENT TARIFFS

UNIT TRAIN	ORIGIN	DESTINATION	ROUTE	MILEAGE	SIZE OF CARS	KIND OF CARS	OWNERSHIP OF CARS
Georgia Power Co.	Captain Mine Percy, Ill.	Wansley, Ga.	ICG-Haleyville, Ala. SOU (SFS)	569	100 Ton	Automatic Rapid Discharge Hopper Cars	Railroad
Commonwealth Edison - Plaines	Captain Mine Percy, Ill.	Plaines Station Joliet, Ill.	ICG	307	100 Ton	High Side Gondolas with Swivel Couplers	Shipper
Commonwealth Edison-Hammond	Captain Mine Percy, Ill.	State Line Sta. Hammond, Ind.	ICG-Joliet, Ill.-EJ&E	356	100 Ton	High Side Gondolas with Swivel Couplers	Shipper
Inland Steel	Inland Mine Sesser, Ill.	Inland Steel Indiana Harbor, Ind.	ICG-Riverdale, Ill.-IHB	284	100 Ton	Conventional Hopper Cars	Shipper
Wisconsin Electric Power	River Queen Mine Madisonville, Ky.	Oak Creek Sta. Milwaukee, Wis.	ICG-Chicago, Ill.-C&NW	516	100 Ton	High Side Gondolas with Swivel Couplers	Shipper
	Orient 6 Mine Waltonville, Ill.			355			
Louisville Gas & Electric	Star Mine Madisonville, Ky.	Cane Run Sta. Louisville, Ky. Mill Creek Sta. Kosmosdale, Ky.	ICG	144	100 Ton	Conventional Hopper Cars	ICG
T. V. A.	Zeigler No. 9 Madisonville, Ky.	Badgett Terminal Grand Rivers, Ky.	ICG	57	100 Ton	Conventional Hopper Cars	ICG
Indianapolis Power & Light	Minnehaha Mine Latta, Ind.	Stout Station Indianapolis, Ind.	CMStP&P-Linton, Ind. ICG	109	100 Ton	Conventional Hopper Cars	Shipper
Illinois Power & Light	Streamline Mine Percy, Ill.	Federal, Ill.	ICG-Vera Ill.-IT	88	100 Ton	Hopper Cars with Mechanical Dump doors	Shipper

NOMINAL CARS/TRAIN	TONS OF COAL PER TRAIN	GROSS TRAILING TONS PER TRAIN	RATE IN CENTS PER TON OF 2,000 POUNDS NOT SUBJ. TO X-281-B	RATE PER NET TON MILE	KIND OF LOADING	TARIFF TIME FOR LOADING	KIND OF UN-LOADING
95	9,500		460 460 424	0.809¢ 0.809¢ 0.746¢	Cable Car System	3½ Hours	Ford Locomotive Pull thru at steady speed on trestle over pit
117 ———	11,700 ———	15,500 ———)Not presently) used.	150.5 165 177	0.491¢ 0.537¢ 0.576¢	Cable Car System	Reasonable Time For Loading	Rotary Dump and Plant Locomotive
87	8,700	11,500	199.5	0.560¢	Cable Car System	No Provision	Rotary Dump and Plant Locomotive
95	9,500	12,600	158	.556¢	Rd. Locomotive Pull Thru At Steady Speed	5 Hours	Rotary Dump and Manual Dump
125	12,500	16,500	330 ——— 291	0.640¢ 0.820¢	Cable Car System-Ky. Rd. Locomotive Pull Thru At Steady Speed In Ill.	5 Hours	Rotary Dump and Plant Locomotive
70	7,000	9,300	145	0.993¢	Car Pulling Mechanism		Manual Dump and Plant Locomotive
70	7,000	9,300	158	2.77¢	Rd. Locomotive Pull Thru At Steady Speed	No Provision	Manual Dump-Cars Positioned By Tractor
50	5,000	6,600	206 Eff. 1-1-74	1.89¢	Individual Cars, Gravity Roll, Rider Breaking	24 Hours	Manual Dump
43	4,300	5,700	84	0.955¢	Individual Cars Gravity Roll Rider Braking	Reasonable Time For Loading	

TABLE VIII-2 Continued

TARIFF TIME FOR UN-LOADING	SETS OF CARS	NOMINAL ROUND TRIP TIME	NOMINAL TRAIN-LOADS PER WEEK	TARIFF ANNUAL MINIMUM TONNAGE	KIND OF LOCOMOTIVE	NOTES	TARIFF AUTHORITY
1½ Hours	1 2 3	63 Hours	2-2/3	1,150,000 Tons 2,300,000 Tons 3,450,000 Tons	24 Axle, 12,000 HP N. of Haleyville; 36 Axle, 18,000 HP S. of Haleyville.		Southern 295
Reasonable Time For Unloading	2 — —	2 Days ——— ———	7	3,300,000 Tons 2,600,000 Tons 2,000,000 Tons	24 Axle, 12,000 HP ——— ———		ICG 6-A
No Provision	1	2 Days	3½	1,200,000 Tons	20 Axle, 11,250 HP		GM&O 3897-C
18 Hours	3	3 Days	7	2,000,000 Tons	12 Axle, 6,000 HP N. of Centralia; 18 Axle, 9,000 HP S. of Centralia.		ICG 3351-C
6 Hours	1	3½ Days	2	1,000,000 Tons	18 Axle, 9,000 HP N. of Centralia; 24 Axle, 12,000 HP S. of Centralia.	Loads in Ky. on Mondays, and in Ill. on Thursdays	ICG 3349-B
12 Hours	2	2 Days	6	1,800,000 Tons	24 Axle, 10,500 HP		ICG 3353-B
No Provision	1	1 Day	5	900,000 Tons	12 Axle, 5,250 HP	Dumped Directly to River Barges	IFA 130-B
24 Hours	2	2 Days	5	900,000 Tons	"	This Train handles considerable other traffic	CMStP&P 18721-A
Reasonable Time For Unloading	2	2 Days	6	1,050,000 Tons		This Traffic is moved in regular train service	ICG 3896-F

Competitive Tariffs

REISSUE
INCREASE

CTC(F) W. 2821
Cancels
CTC(F) W. 2811

CANADIAN NATIONAL RAILWAYS

(Lines Armstrong, Thunder Bay, ON., and West thereof)

CNR W. 1032-F
Cancels
CNR W. 1032-E

SPECIAL LOCAL EXPORT FREIGHT TARIFF

on

COAL

Carloads

FROM

Luscar, AB.

TO

North Vancouver (Neptune Terminals), BC.

(Applicable only on shipments destined to Japan)

Governed, except as otherwise provided herein, by Canadian Freight Classification 22, P. J. Lavallee, Agent, CTC(F) 1740, and by supplements thereto or successive issues thereof.

ISSUED MAY 13, 1974 EFFECTIVE MAY 13, 1974
(Expires with March 31, 1975, unless sooner cancelled, changed or extended).

Issued by
F. W. MILNE,
Chief of Tariff Bureau,
123 Main St.,
Winnipeg, MB.,
R3C 2P8

(Printed in Canada) (CO-20-20) (1/10)

COAL, in trainload lots, consisting of not less than 85 cars but not exceeding 101 cars. (See Exception).

EXCEPTION—The carrier, upon giving notice to the shipper, shall have the right to alter the number of rail cars, provided the service shall not deteriorate and shall be equal to the service contemplated.

Carloads, minimum 100 tons of 2,000 lbs. per car, but in no case to exceed the stencilled load limit on the car.

Annual volume not less than 1,400,000 tons of 2,000 lbs. during each twelve-month period commencing April 1, 1974. (See Note).

FROM	TO	Rate in cents per ton of 2,000 lbs.
Luscar.........................AB.	North Vancouver (Neptune Terminals)....................BC.	♦551

NOTE—Any deficiency in annual volume shall be assessed at $1.15 per ton of 2,000 lbs. Any surplus of coal made available to CNR for carriage in unit trains in any year up to a maximum of 140,000 tons may be applied against shortages which have occurred in prior years or which may occur in subsequent years during the effective period of this tariff. Tonnage in excess of 1,540,000 tons made available to CNR in any one year shall be carried under CNR's then applicable general tariff.

Issued in compliance with CTC Special Permission No. 5285, dated May 10, 1974.

♦ Denotes increase.

SPECIAL TERMS AND CONDITIONS GOVERNING THE TRANSPORT OF COAL IN TRAINLOAD LOTS

1. Does not include special services at origin, destination or in transit for which special tariffs or tolls are published under the Railway Act except as otherwise provided herein.

2. This tariff is intended to deal with the said traffic only in respect of rates for general transportation services except as otherwise provided herein.

3. Shipper shall be responsible for loading the coal in rail cars and all costs and expense of such loading shall be for shipper's account.

4. Shipper shall be responsible for and shall establish the weight of the coal in each train at the point of origin. The method of weighing the cars shall be one acceptable to the carrier.

5.(a) Shipper shall provide, at its sole expense, sufficient rail trackage at the point of origin and in such configuration to assure safe and proper handling of the trains during the entire loading operations.

(b) Shipper shall be responsible for and shall move the train through the loading facilities at the point of origin; the unit train shall be handled through the loading facilities one half at a time.

(c) Shipper shall load each section of the train (each section not to exceed 60 cars) and perform all necessary inspection of the rail cars within three hours of the arrival time of the section at the loading facilities.

(d) Shipper shall ensure that all rail cars are properly coupled, that all air hoses are properly connected and that the train line is properly charged when each section of the train leaves the loading facilities and when the train leaves the point of origin.

(e) Shipper shall load the entire train which shall not exceed 101 rail cars and return it to the carrier at the designated track at the point of origin within six hours of delivery by the carrier of the first section of the train to the designated receiving track at the point of origin.

6. Shipper shall, at its sole expense, carry out all cleaning of the rail cars used in this train service.

7. Shipper shall be responsible for unloading the coal from rail cars at Neptune Terminals unloading facilities, North Vancouver, BC., and all cost and expense of such unloading shall be solely for shipper's account.

8. The unloading facilities at the point of destination shall be modern and efficient and shall be able to handle rotary dump rail cars. They shall be capable of continuous operation and shall have a capacity sufficient to unload within six hours, 101 rail cars, each having load capacity of 200,000 lbs.

9. Shipper shall maintain the unloading facilities in proper operating condition.

10.(a) Shipper shall unload the entire train and return it to the carrier at the designated track at the point of destination within six hours of its delivery by the carrier to the designated receiving track at the point of destination.

(b) Shipper shall be responsible for and shall move the train through the unloading facilities at the point of destination.

(c) Shipper shall ensure that all rail cars are properly coupled, that all air hoses are properly connected and that the train line is properly charged when the train is re-delivered at the designated track at the point of destination.

(d) Shipper shall provide, at its sole expense, sufficient rail trackage at the point of destination and in such configuration to receive the entire loaded train intact from the carrier and to handle it properly and efficiently through the unloading facilities.

(e) Such trackage shall be available for the service on a continuous basis when each train is scheduled to arrive at the point of destination unless another coal train already occupies the unloading facilities in which case such trackage shall be made available for this service with the utmost dispatch and in any event will be made available within six hours of its being required for this service.

SPECIAL TERMS AND CONDITIONS GOVERNING THE TRANSPORT OF COAL IN TRAINLOAD LOTS (Concluded)

11. At all times that any rail car is in the custody of the shipper it shall be handled in accordance with all good and safe railway operating procedures.

12. Any train schedule established to move trainload lots under the terms and conditions of this item shall be based upon the requirements of Paragraphs 5(d) and 10(c) being met by the shipper.

13. If any rail car is damaged or found to be damaged by shipper after it has been handled through the loading or unloading facilities, shipper shall immediately notify the carrier.

14. The freight rate does not cover switching charges at the point of origin other than placement of the first rail car of each half of each train under the loading tipple.

15. The freight rate does not cover switching charges at the point of destination other than the placement of the entire train at the designated receiving track.

16. Car equipment will be solid bottom gondolas equipped with rotary couplers at one end in assigned service, sufficient to move stated volume as agreed to between shipper and CN at commencement of movement.

17. If either gondolas equipped with rotary couplers or bottom dump cars must be supplied to the shipper by the carrier because a car has had to be withdrawn from the service and such withdrawal is attributable to the negligence of the shipper, its servants, agents, employees or contractors, and so often as it shall occur, shipper shall, in addition to the freight rate, pay to the carrier the amount of $15.00 per car per day for the supply of each standard hopper car. The carrier shall make every effort to return to service as quickly as possible any car so withdrawn.

18. Demurrage charges and regulations published in Canadian Freight Association Tariff No. 114-0, CTC(F) No. 849, A. W. Juvonen, Agent, will not apply.

19. Rate is exclusive of all terminal charges at port of export.

20. The trainload shipments shall be tendered to the carrier on a single preprinted document with sufficient copies for use as the Bill of Lading and the Waybill.

EXPLANATION OF ABBREVIATIONS

AB............Alberta
BC............British Columbia
CNR..........Canadian National Railways
CTC..........Canadian Transport Commission - Railway Transport Committee
MB...........Manitoba
ON...........Ontario

(FINIS)

ADVANCE

REISSUE
INCREASE

CTC(F) W. 2829
Cancels
CTC(F) W. 2812

CANADIAN NATIONAL RAILWAYS

(Lines Armstrong, Thunder Bay, ON., and West thereof)

CNR W. 1034-F
Cancels
CNR W. 1034-E

SPECIAL LOCAL EXPORT FREIGHT TARIFF

on

COAL

Carloads

FROM

Winniandy, AB.

TO

North Vancouver (Neptune Terminals), BC.

Governed, except as otherwise provided herein, by Canadian Freight Classification 22, P. J. Lavallee, Agent, CTC(F) 1740, and by supplements thereto or successive issues thereof.

ISSUED AUGUST 23, 1974 EFFECTIVE OCTOBER 1, 1974
(Expires with March 31, 1975, unless sooner cancelled, changed or extended).

Record Copy
CN H.Q. Bldg.
NOT to be Removed

Issued by
F. W. MILNE,
Chief of Tariff Bureau,
123 Main St.,
Winnipeg, MB.,
R3C 2P8

(Printed in Canada) (CO-20-20) (140)

COAL, in trainload lots consisting of not less than 85 cars but not exceeding 101 cars supplied by the shipper. When the shipper requires a train of less than 85 cars, such train shall be billed at a minimum of 8,500 tons. (See Exception).

EXCEPTION—The carrier, upon giving notice to the shipper, shall have the right to alter the number of rail cars, provided the service shall not deteriorate and shall be equal to the service contemplated.

Carloads, minimum 100 tons of 2,000 lbs. per car, but in no case to exceed the stencilled load limit on the car.

Annual volume not more than 2,464,000 tons of 2,000 lbs. during each twelve-month period commencing April 1, 1974. (See Note).

FROM	TO	Rates in cents per ton of 2,000 lbs.
Winniandy.....................AB.	North Vancouver (Neptune Terminals)...................BC.	♦384

NOTE—Tonnage in excess of 2,464,000 tons made available to CNR in any one twelve-month period shall be carried under CNR's then applicable general rate tariff.

♦Denotes increase.

SPECIAL TERMS AND CONDITIONS GOVERNING THE TRANSPORT OF COAL IN TRAINLOAD LOTS

1. Does not include special services at origin, destination or in transit for which special tariffs or tolls are published under the Railway Act except as otherwise provided herein.

2. This tariff is intended to deal with the said traffic only in respect of rates for general transportation services except as otherwise provided herein.

3. Car equipment will be solid bottom gondolas equipped with rotary couplers at one end. Shipper shall supply a sufficient number of rail cars to handle the volume offered. Under no circumstances shall the carrier pay mileage allowance or car rental on rail cars provided by the shipper while in this service.

4. Shipper shall be responsible for loading the coal in rail cars and all costs and expense of such loading shall be for shipper's account.

5. Shipper shall be responsible for and shall establish the weight of the coal in each train at the point of origin and shall ensure individual cars do not exceed stencilled capacity. The method of weighing the cars shall be one acceptable to the carrier.

6. (a) Shipper shall provide, at its sole expense, sufficient rail trackage at the point of origin and in such configuration to assure safe and proper handling of the trains during the entire loading operations.

(b) Shipper shall be responsible for and shall move the train through the loading facilities at the point of origin.

(c) Shipper shall load each train and perform all necessary inspection of the rail cars, together with its obligations under sub-paragraph (d), within four hours of the arrival time of the train at the loading facilities.

(d) Shipper shall ensure that all rail cars are properly coupled, that all air hoses are properly connected and that the train line is properly charged when each train leaves the loading facilities and when each train leaves the point of origin.

7. Shipper shall, at its sole expense, carry out all cleaning of the rail cars used in this train service.

8. Shipper shall be responsible for unloading the coal from rail cars at Neptune Terminals unloading facilities, North Vancouver, BC., and all cost and expense of such unloading shall be solely for shipper's account.

9. The unloading facilities at the point of destination shall be modern and efficient and shall be able to handle rotary dump rail cars. They shall be capable of continuous operation and shall have a capacity sufficient to unload within six hours, 101 rail cars, each having load capacity of 200,000 lbs.

10. (a) Shipper shall unload the entire train and return it to the carrier at the designated track at the point of destination within six hours of its delivery by the carrier to the designated receiving track at the point of destination.

(b) Shipper shall be responsible for and shall move the train through the unloading facilities at the point of destination.

(c) Shipper shall ensure that all rail cars are properly coupled, that all air hoses are properly connected and that the train line is properly charged when the train is re-delivered at the designated track at the point of destination.

(d) Shipper shall provide, at its sole expense, sufficient rail trackage at the point of destination and in such configuration to receive the entire loaded train intact from the carrier and to handle it properly and efficiently through the unloading facilities.

(e) Such trackage shall be available for the service on a continuous basis when each train is scheduled to arrive at the point of destination unless another coal train already occupies the unloading facilities in which case such trackage shall be made available for this service with the utmost dispatch.

SPECIAL TERMS AND CONDITIONS GOVERNING THE TRANSPORT OF COAL IN TRAINLOAD LOTS (Concluded)

11. At all times that any rail car is in the custody of the shipper it shall be handled in accordance with all good and safe railway operating procedures.

12. Any train schedule established to move trainload lots under the terms and conditions of this tariff shall be based upon the requirements of Paragraph 6 (d) and 10 (c) being met by the shipper.

13. If any rail car is damaged or found to be damaged by shipper after it has been handled through the loading or unloading facilities, shipper shall immediately notify the carrier, and the train shall not be moved until such rail car is repaired or removed.

14. (a) Shipper shall, at its sole expense, maintain and repair each rail car supplied by it for this service.

(b) Where for any reason a rail car in this service is in the carrier's possession and requires repairs of whatsoever nature, the carrier shall carry out such repairs at shipper's sole expense on the basis of the Interchange Rules of the Association of American Railroads as such rules apply to leased rail cars.

15. If shipper is not in default of its obligations under Paragraph 3, and a number of shipper-supplied cars are damaged or destroyed so that a full train consist cannot be maintained, then the carrier shall use its best efforts to supply on a temporary basis substitute gondolas equipped with rotary couplers or bottom dump cars for this service. Where the cause of such car shortage is not the negligence of the carrier shipper shall, in addition to the freight rate, pay to the carrier an additional rental charge for the supply of each such car. Where the cause of such car shortage is the negligence of the carrier the rental charge shall be waived.

16. The shipper covenants and agrees to pay the carrier $600.00 for each and every delay in excess of eight hours occasioned to a unit train, as a result of failure to accept and process a unit train on arrival at the point of origin or point of destination.

17. The freight rate does not cover switching charges at the point of origin other than placement of the first rail car of each train under the loading tipple.

18. The freight rate does not cover switching charges at the point of destination other than the placement of the entire train at the designated receiving track.

19. Demurrage charges and regulations published in Canadian Freight Association Tariff No. 114-O, CTC(F) No. 849, K. W. Juvonen, Agent, will not apply.

20. Rate is exclusive of all terminal charges at port of export.

21. The trainload shipments shall be tendered to the carrier on a single preprinted document with sufficient copies for use as the Bill of Lading and the Waybill.

EXPLANATION OF ABBREVIATIONS

AB..........Alberta
BC..........British Columbia
CNR.........Canadian National Railways
CTC.........Canadian Transport Commission - Railway Transport Committee
MB..........Manitoba
ON..........Ontario

(FINIS)

REFERENCES

1. Zar, M., "Unit Trains," Power Engineering, October 1966, pp. 48-51, and Snouffer, R. D. and Hanson, V. D., "The Unit Train Concept of Coal Transportation," presented at the 26th Annual Meeting of the American Power Conference, Chicago, Illinois, April 14-16, 1964.

2. U.S. Department of the Interior, Bureau of Mines, Comparative Transportation Costs of Supplying Low-Sulfur Fuels to Midwestern and Eastern Domestic Energy Markets, IC 8614 (1973).

IX. FACILITIES

Ownership of a single large mine or the single ownership of several mines confers a number of advantages: 1) equipment is standardized, 2) there are advantages of large scale purchasing, 3) there can be an optimal geographic location of repair, maintenance, and warehousing facilities, and 4) there may be advantageous borrowing rates, access to capital markets and the internal generation of capital. Cooperatives, on the other hand, are made up of several small mines with decentralized management and only a relatively thin layer of management superimposed for specific joint activities.

Section V indicates the diversity of preparation of equipment available, some of which may be situated at each mine. The diversity is actually greater than that indicated. Furthermore, mining equipment is also diverse. All are obtained from a fairly lengthy list of suppliers. The cooperative may lead to a higher degree of standardization but only over time. For this reason, at least initially, the coop will not be able to take significant advantage of large scale purchasing. Only on a potential buyer basis may they be able to secure better terms than any individual small mine owner.

Repair and maintenance are on-site operations. The geographic diversity of each coop suggests that each mine will

still require some on-site facilities. However, major repairs can be done centrally. Most coal preparation equipment (except perhaps crushers) and loading equipment will fall into the latter category.

Cost advantages accrue to central warehousing. However, relative access may make this site a matter of dispute. As the standardization program progresses, the complexity of the warehouse storage and identification problems decrease.

Perhaps the greatest advantage to the cooperative may accrue in the area of finance. Depending on how tightly drawn the mines are and how secure the coal purchaser is, due to the use of the unit train, at least interest rates on borrowing should be lower than those obtainable by individual mines. Access to other than local capital markets is unlikely to be significantly enlarged. Additional internal generation of capital is not a factor unless the mine owners become closer than a cooperative implies.